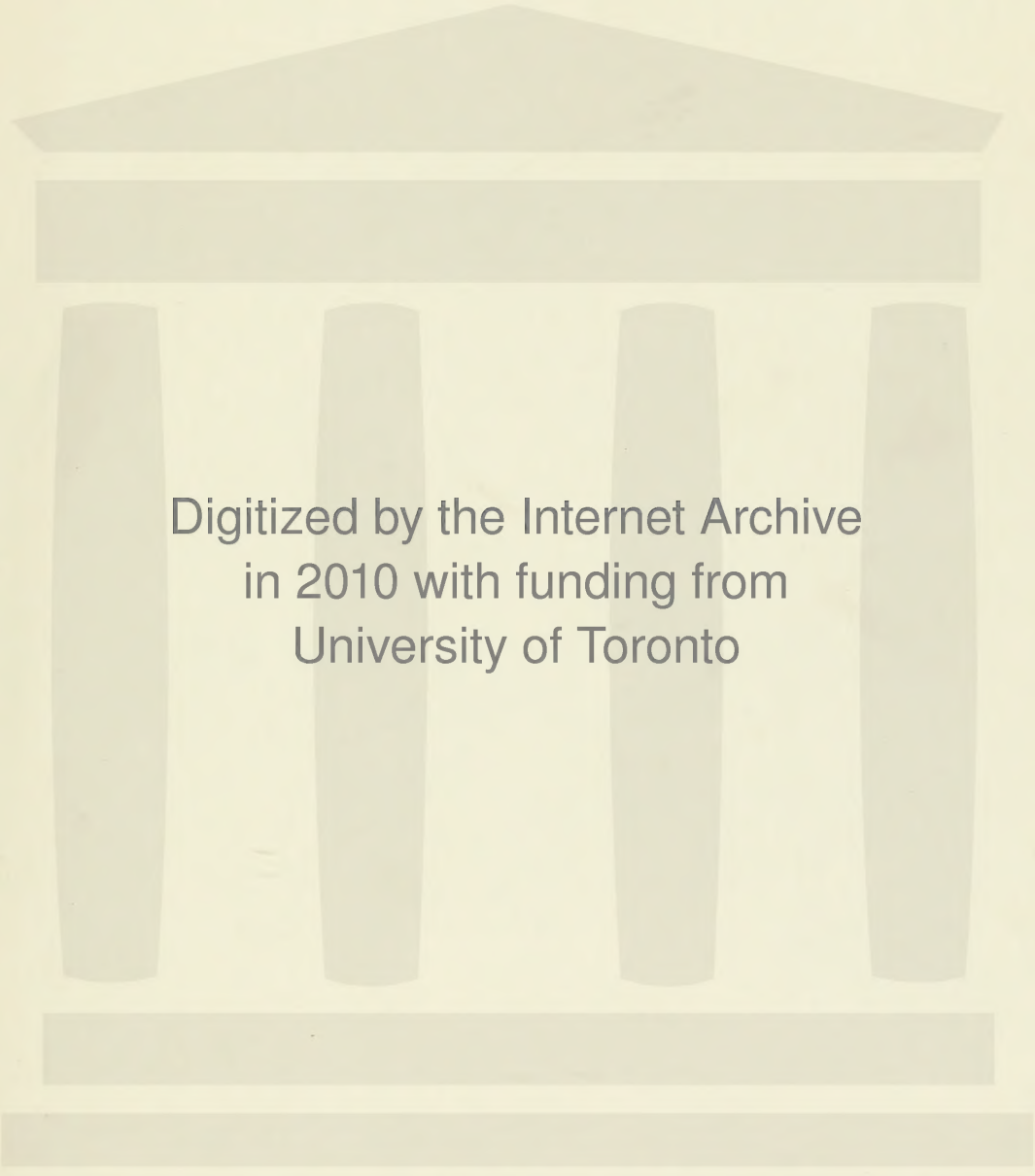
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The Canadian Engineer

An Engineering Weekly

CONCRETE FACTORIES.

The varied uses of cement in industrial constructions grow apace with increased manufacture and decreased cost of the staple. The American Association of Portland Cement Manufacturers have gathered data together which shows the possibility of all steel and cement construction as applied to factories, warehouses and other buildings necessitating commodious floor space.

To an engineer about to assume the responsibility of the erection of an industrial structure, the employment of concrete would have to be considered in the specific case.

Concrete Motor Car Factory.

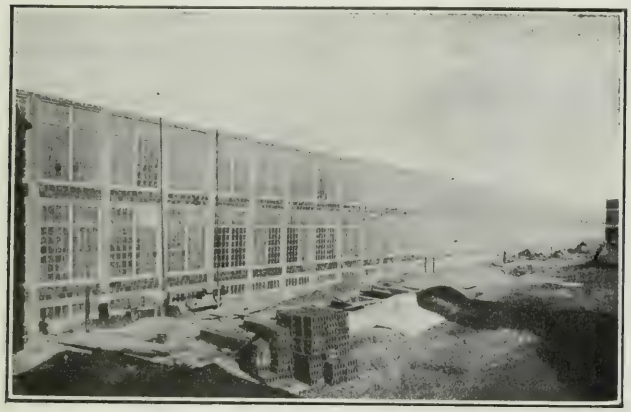
It is very interesting, however, to examine the points brought forward by the cement association mentioned above.

From an industrial point of view, the advantages of a reinforced concrete building are its fireproofness, waterproofness, verminproofness, sanitary qualities, maximum light available, load-carrying capacity, vibration, resistance, permanence, adapability, speed of construction, low heating charge, low initial cost and its fire protection value.

Compared to any other fireproof type of building, reinforced concrete for industrial buildings is the lowest in initial cost. It is generally found that on a four or more storey factory or warehouse, with live loads of 150 pounds or more, reinforced concrete buildings cost from 10 per cent. to 20 per cent. or even 25 per cent. less than a similar design in structural steel properly fireproofed. Compared to non-fireproof buildings, concrete will vary from equal cost on large propositions to possibly 30 per cent. greater cost on medium sized propositions, and sometimes 40 per cent. and 50 per cent. on the smaller buildings when the comparison is made with the cheapest form of brick and frame construction. These percentages will, of course, vary for different sections of the country, but are in a measure fair statements for general usage. These costs are exclusive of building equipment such as plumbing, heating, lighting, elevators and sprinklers, as these items run about the same on any type of building. What these costs really mean is that a prospective builder can obtain a fireproof structure, if he uses reinforced concrete, at a cost little in excess of the non-fireproof or at best slow-burning form of construction. Before the introduction of reinforced concrete construction the only fireproof form of building was structural steel fireprofed.

A reinforced concrete building gives very nearly full protection from fire. Even though the building is in a conflagration district, if it is properly protected with wire glass windows, fire doors, etc., it will, as far as it is pos-

ible to judge, come through a conflagration uninjured. If he fire is a local one, it would be confined to the floor or oom where it started. The underwriters' records of the Jnited States show that there are forty fires causing loss in xcess of $25,000 per fire every week among industrial build-ngs in that country, and that the annual per capita loss for he United States is something in excess of $2.30 as com-ared to an average loss per capita of seven European cities f 30 cents. The cost of a reinforced concrete fireproof uilding under most conditions would not exceed a non-reproof type of building by over 10 or 15 per cent.



Concrete Cotton Factory.

The most serious damage to the contents of a building fter a fire is due to water. To this condition, concrete uildings owe much of their popularity at the present time. concrete floor is a monolith, and water from sprinklers or ose will remain on the floor where it falls and does not un down through several storeys as in the case of ordinary ypes of construction. The best practice of the day in the esign of concrete industrial buildings provides a small urb, generally not over three inches high, at all stair and evator wells, lowerator shafts, and other openings through oors, so that there is no possibility of water from a flooded oor flowing into the lower story. To make this certain scup-ers are usually placed in the walls. Furthermore, the aterproofness of a reinforced concrete building is of great ervice where industries using wet processes have to be oused, or where industries requiring frequent cleaning of ooms or floors are the tenants. A concrete building may be ashed down with a hose and no damage results. The new ork Board of Fire Underwriters are accepting concrete oors with a granolithic finish placed on two inches of rich nder concrete as waterproof and give the same rating as her types of floors which have three- or five-ply tar and lt waterproofing laid between the structural part of the oor and the floor surface.

A building where there is no dry rot, no dampness, no ermin, and where cement, which is a lime product and aturally sanitary, is the chief material of construction, is ery nearly ideal from a hygienic viewpoint.

The sanitary qualities of a building and efficiency of em-oyees vary almost directly with the amount of light obtain-ble in a building. Concrete factories are noted for the ease ith which abundant light is obtainable in them. The rdinary brick and mill construction and brick or frame uilding has rarely over 20 or 30 per cent. of its wall area windows, whereas the normal window area for a reinforced oncrete factory is 50 per cent. and in many cases runs as igh as 85 per cent.

Owners of concrete buildings have shown that they can crease the efficiency of their employees 5 to 10 per cent., and often even more, by having well-lighted, clean rooms. Concrete buildings possess an advantage over most other types of construction along this same line, not merely from the extra amount of light available, but also from the extra ventilation which the large window area gives. This is of importance, especially through the summer months.

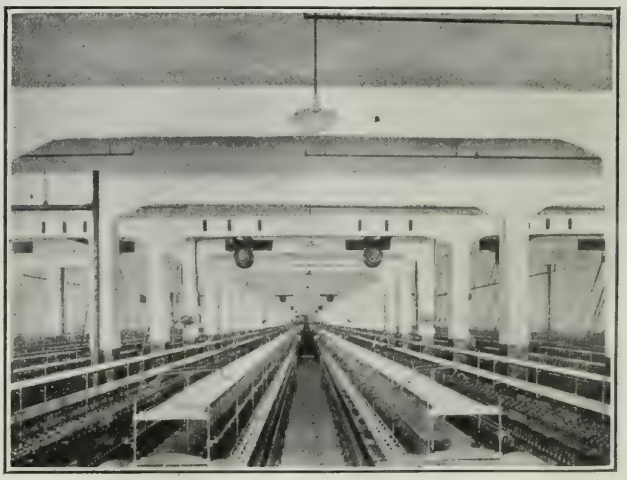
The great window area which is obtainable in reinforced concrete factories reduces the lighting charges materially and in many cases makes artificial light almost unnecessary. Light courts or very narrow buildings often become unnecessary when reinforced concrete is used. By allowing the windows to extend to the ceiling line the light from these windows will reach 40 or 50 feet into the building in an efficient manner.

Reinforced concrete increases in strength with age. There are many tests of cement and concrete briquets and cubes which demonstrate beyond controversy the increase in strength with time.

Poor workmanship and unusual conditions have sometimes occurred on buildings, but the material after once in position has always responded without a single sign of weakness. Concrete floors which have been designed for a strength of 200 pounds have been known to carry 500 and 600 pounds, and floors which have been designed for loads of 600 pounds are carrying 1,200 and 1,500 without incurring the slightest defection.

Concrete floors have been built to carry as high as 5,000 pounds per square foot, and it may be safely stated that a concrete building designed for the same loading as is used in any other type of building is by far the stronger of the two.

An interesting commentary on the strength of concrete buildings is found in the latest practice in design which is becoming more and more prevalent. Advantage is taken of the increase in strength with time of a concrete building. If



Interior of Concrete Cotton Factory.

an owner desires a building to be four stories high, but to be so built as to later carry a fifth story, the columns are designed to carry the loads which will be brought on them if the building were to be ultimately only four stories high. At the end of a year or two these columns will have increased in strength to such an extent that a fifth story can be safely added, and the resulting loads on the columns will not produce stresses above the factor of safety used in the original design.

A reinforced concrete factory or warehouse, properly designed and erected, may be said to be the most rigid building which can be put up. The reason for this is almost self-evident. The floors and columns of a concrete building are

cast or poured at one time, and become a homogeneous mass, that might have been carved out of a solid block of stone. Rapidly moving machines, heavy embossing presses, electric motors, milling machines, high velocity engines, and, in fact, any heavy equipment can be installed in a reinforced concrete building and run at highest speed and in the story below its presence is scarcely discernible. It has been found that machinery can be operated at higher speeds and at greater efficiency in concrete buildings, owing to the rigidity of these buildings, than in any other type of construction. While it is true that there are some concrete buildings where vibration is noticeable, the conditions in these buildings are such as to create vibration in any kind of a structure, and the amount existing in the concrete building is certainly less than would otherwise be obtained. Concrete was early selected for the housing of the publishing and printing industry because it permitted the placing of large presses in upper floors of the building, without danger to the safety of the structure.

One type of vibration which concerns many manufacturers is due to a very slight lack of balance in parts rotating at high speed. This is in distinction to the vibration that might be caused by machinery of a heavier type due possibly to the reciprocation of heavy weights or to the shock, as in punch press work and the like, or vibration of a machine due to "chatter." It has been found that in reinforced concrete factories the usual difficulty of installing machinery so that high frequency vibration would not in a short time loosen the fastenings, as well as cause loss of adjustment to the machines, has been almost enirely overcome. It has further been found that machines standing high from the floor and subject to more or less horizontal shock can be held rigidly in place. This is a condition which in mill construction, at least, is almost impossible to bring about.

The effect of this property on the tenant of a factory is great. If machinery or shafting can be set or bolted to a

Iron Company Concrete Core Room and Carpenter Shop.

concrete floor, or hung from the ceiling without the possibility of its getting out of line or level, the repairs to the machines in new bearings, the amount of attendance, the quantity of oil used, and the general up-keep are greatly reduced. Many owners of concrete industrial buildings have found that they save considerable money by having their machinery in this type of building, as compared with any other type of structure.

In many light manufacturing buildings consideration has to be given to the position of heavy stock piles or machines, it being necessary either to place extra heavy loads over a beam or girder or make provision to distribute the load. In concrete buildings this rarely occurs. Furthermore, in the ordinary type of building the movement of an unusually heavy load across the floor often disturbs the shafting or other machinery hung from the ceiling below. In concrete construction the foreman of a department seldom has to think of such a contingency.

The speed of construction of reinforced concrete buildings has been misrepresented many times, and a number of buildings have been designed in mill construction because their owners were afraid that if they elected to use reinforced concrete there would be such delays as to make the use of concrete prohibitive. There have been, it is true, many concrete buildings put up where the time of completion has dragged along to an unreasonable extent, and the owners

Concrete Meter Factory.

have had every reason for complaint. Most of such cases, however, have been due chiefly to inexperience on the part of the contractor or unreasonable requirements on the part of the engineer or owner.

With an experienced contractor, and ordinarily fair working conditions, reinforced concrete factories or warehouses can be, and in innumerable instances have been, erected in a time which compares favorably with any other type of construction. Speed in concrete work means essentially a well organized and experienced contractor.

A few instances of quick concrete construction would include:—

The Mason Warehouse at 134 Johnson Street, Brooklyn, New York, is 40 by 80 feet in plan, seven stories and basement in height. After the completion of the excavation but forty-eight working days were used to the completion of the roof, and the building was turned over ready for occupancy, including plumbing, heating, lighting, and elevators, in three months and one-half after the signing of the contract.

The Rogers-Pyatt shellac factory at 34 Fletcher Street, New York City, is ten stories and basement in height, and about 60 by 70 feet in plan. After the completion of the foundations, which were special, forty-seven working days were consumed to the concreting of the roof and three and one-half months elapsed from the signing of the contract to the delivery of the building ready for occupancy.

The Robert Gair warehouse, on Front and Washington Streets, Brooklyn, New York, a twelve-story building with twenty thousand square feet to the floor, was constructed, twelve floors in eleven weeks, and the building turned over ready for occupancy in seven months after the signing of the contract.

It is the general practice of reputable concrete construction companies to carry their buildings up at the rate of a story per week after the first floor is concreted. A seven-story building, about ten thousand square feet to a floor, can be guaranteed completed in from four to five months after the contract is signed.

An investigation of over 200 reinforced concrete industrial buildings showed that in none of them was any damp-

oofing placed. All the buildings have given perfect satis- tion on this score. Concrete walls 8 inches in thickness, operly built, are practically impervious to weather. In ses where the temperatures are high there may be a ten- ncy towards condensation, but this would be true with y character of wall which was not furred to provide a dead space. The prevalence of the idea that concrete build-

Interior of Concrete Embossing Factory.

rs are damp probably is founded on the old-fashioned con- te cellar or rubble wall cellar, which was under a static id of water, and, therefore, very liable to dampness. stering may be applied direct to the inside of concrete lls 8 inches or more in thickness without danger of the stering coming off. The fact that piano factories, which uire about as dry a building as any other type of indus- , have been built of reinforced concrete most satisfactorily, nishes an interesting example of the lack of dampness in crete buildings.

In exterior appearance a concrete building, as illustrat- will compare in appearance favorably with any other type building when designed accordingly. The old prejudice the part of the general public against concrete from the hetic point of view is due to the psychological fact that at the eye has not seen the brain cannot conceive. The n in the street has come to know brick, stone, and older es of exterior construction and to accept them for what y are and to distinguish between good work and bad work the various classes. Until there has been enough con- te work for the public to become used to it and to learn distinguish between good concrete and bad concrete, there bound to be somewhat of a feeling against it. Admitting s condition, it is not necessary for the prospective builder turn down concrete as a structural material. Rather, he uld use brick, stone or whatever material suits his whim a veneer or as bearing walls and let the structural part his building be of concrete. In other words, reinforced crete may be used for the frame of a building in the same y that structural steel is used for skyscrapers the country r.

Difficulty of Installing Mechanical Equipment.—Perhaps most common prejudice against reinforced concrete for ustrial buildings is the supposed difficulty of installing in satisfactory and economical manner, piping, machinery, tors, and other merhanical equipment. While it is un- ubtedly true that it is harder to cut into a concrete ceiling beam than into wood or brick, the extra amount of labor d time involved is much less than those inexperienced in ch work would imagine. As a matter of fact, in the ma- ty of industrial concrete buildings erected to-day pro- vision is made during the course of construction so that equipment of every character can be readily installed with- out any cutting whatsoever. This is generally accomplished by leaving holes sufficiently large to take a ¾-inch bolt through the beams and girders just underneath the floor slab. These holes are spaced generally from 24 to 36 inches on centres. By use of hanger bolts or sockets, any kind of equipment can be supported rigidly from the concrete ceil- ings. In construction where there are no beams or girders, cast-iron spool sockets are set at regular intervals in the ceiling. These sockets are tapped for bolts of any size and provide a very simple means of attaching machinery. In fact, these cast-iron spool sockets are not infrequently set in the bottoms of beams or girders or in the floor slabs be- tween same. Shafting is ordinarily supported on 3-inch by 6-inch wooden stringers which are bolted to the concrete ceil- ing. As previously noted, machinery or shafting thus attach- ed to concrete construction remains rigidly in place without any of it getting out of line or level which is so common in other types of buildings.

The installing of plumbing, heating, and sprinkler pipes is handled usually in a different manner from other me- chanical equipment, in that it is customary to write contracts and specifications for concrete buildings with the provision that the sub-contractors for these different classes of work have to set sleeves or indicate where they wish holes left in the concrete construction before the floors or walls are con- creted. It is then up to the concrete contractor to meet their requirements.

Most machinery is set on the floors and not supported from the ceiling. Two problems are then presented: First, where the machinery is sufficiently heavy so that it may rest

Interior of Concrete Bakery.

without bolting upon the concrete floors or be grouted in place; and, second, light machines which have to be secured to the floors. The first class of work is obviously simple and needs but little attention except to note that concrete floors lend themselves very readily to grouting, and, in their stiffness, prevent any tendency towards movement of ma- chines. The second class of machinery is provided for gen- erally in two ways: First, by drilling holes from two inches to three inches deep in the concrete floor and either driving wooden plugs into these holes and then attaching the machine by use of ordinary bolts or screws or by setting expansion bolts in the holes direct and hold- ing them in place with lead or sulphur. The drill- ing of these holes may, in the eyes of the uninitiat- ed, form a problem. As a matter of fact, it has been found in actual practice that these holes can be tapped in the con-

crete floors very easily. The second class of machinery, which the drilling of the holes and the setting of anchor or expansion bolts does not take care of, consists of very light machines or machines which have to be moved frequently. Here it is generally good practice to install over the concrete structural slab a wooden floor to which the machines may be bolted as in an ordinary building. Most reputable concrete engineers and contractors, although very enthusiastic over their form of construction, are not blind to certain conditions which something other than concrete had best be specified.

If provision is made beforehand, such as above noted, equipment can satisfactorily be installed in concrete buildings. Assuming that no provision has been made during the construction of the building for attaching any mechanical equipment. The general practice among the occupants of concrete buildings is to use expansion bolts set in holes tapped in the concrete. In a large building where there is a great amount of such work to be done or where changes are constantly occurring, the most economical way to meet this problem is to purchase a small portable air compressor, generally operated by electricity, and use a pneumatic drill. The cost of such a compressor is low and the economies which it effects soon more than equal the initial outlay. But even in a building where such a machine is not available, it has been found that holes can be cut into concrete at an almost negligible cost. The results of an investigation of some fifty concrete buildings in the Metropolitan district of New York City about a year ago showed that the mechanical engineers or factory superintendents, after the first few weeks of occupancy of their new buildings, got to regard cutting holes in concrete beams, for the setting of expansion bolts or other devices, about as they did cutting into wooden beams. This may at first seem to apply wholly to machinery or shafting. Alterations in piping layouts require, of course, cutting holes through floors or walls or partitions. This is somewhat more difficult than the tapping of expansion bolt holes, but if a little discretion is exercised it will be found that alterations of this kind are not really burdensome. It is sometimes objected that additions may be necessary to buildings which require removal of walls, or departments may have to be moved from one part of the building to another, which may require removal of partitions. In cases such as this concrete should not be used for walls or partitions. Exterior walls should be built of a material which can be readily removed. Partitions should be made of concrete blocks or hollow tile or lath and plaster, which brings this problem to the same footing as in other types of construction.

Coal pockets above 3,000-ton capacity cost from $6.00 to $7.50 per ton. Reinforced concrete stand pipes above the foundations cost from 2½ to 3 cents per gallon.

It is difficult to give a comparative insurance rate on industrial buildings in Canada owing to each one being rated specifically, local circumstances having entire control over the schedule. A concrete building reinforced with steel, and provided with metal window sashes supporting wire glass, and containing little or no interior woodwork, is rated by fire underwriters as "fireproof." The insurance rate on such a building in Ontario runs from 0.20 cent per $100.00 per twelve months upwards.

The estimated approximate unit costs of reinforced concrete buildings of various types are shown in the table below:—

Type of building. Dimensions.	Live lead. per sq. ft.	Cost above foundation. sq. ft.	Cost above foundation. cu. ft.	Cost includ'g foundation, sq. ft.	Cost includ'g foundation, cu. ft.
Machine shop, 120x50′, 4 stories	150	$1.05	$0.08	$1.17	$0.09
Machine shop, 220x100′, 1 story, sawtooth skylights		1.65	0.09	1.75	0.10
Cartridge factory, 223x56′, 2 stories	300	1.40	0.09	1.55	0.10
Cotton mill, 550x129′, 2 stories	75	0.99	0.07	1.06	0.075
Weave shed, 341x231′, 1 story, sawtooth skylights	125	1.66	0.064	1.79	0.07
Power-house, 90x62′,		2.53	0.115	2.67	0.12
Storehouse, 181x56′, 4 stories	150	1.08	0.065	1.15	0.07
Storehouse, 256x100′, 12 stories	150	0.90	0.09	0.98	0.105
Storehouse, 223x56′, 2 stories	300 and 1,000	1.20	0.08	1.35	0.09

LIGHTNING RODS.

In arranging aerial and ground connections in a system of lightning rods, the different rods are connected together on the roofs of the house. The rods situated on the gables, and on this account more exposed to the action of lightning, are always each provided with a separate conductor, one conductor to every two rods being sufficient in the case of those lower down. A conductor consists either of a copper wire 8 to 10 millimeters thick, or of copper wire rope containing seven wires 3.3 millimeters each in diameter. Only electrolytically pure copper should be used. Galvanized-iron wire cable, 15 millimeters thick, composed of twelve single wires 3.3 millimeters in diameter, is also employed. Large metallic bodies in the interior of the building, such as iron girders, iron pillars, rain, gas, and water pipes, metal roofs, etc., should be brought into good conducting connection with the conducting rods by screws and soldering. The object of the ground connection is to conduct the lightning to the earth with the least possible resistance. For this purpose copper plates 2 millimeters thick and from 0.5 to 1 square meter in area are generally employed. If there are more than two ground plates to one conductor, the size of the plates can be reduced to 33 by 100 centimeters. Galvanized-iron plates 1 square meter in area and 5 millimeters thick, iron rails, water mains (when allowed by law) can also be used for ground connection. The plates should be fixed in underground water, and far enough to remain covered when the water is at its lowest. If there is no ground water available, the electrode should be fixed in the moistest soil possible, e.g., in the neighborhood of rain spouts, kitchen drains, etc. In this case the surface of the electrodes must be doubled. Instead of solid ground plates, copper or iron wire netting may be used, but in selecting the size, care must be taken that they present the same conducting surface as the solid plates, i.e., one square meter. If the ground plate has to be placed in a well from which drinking water is taken, a galvanized-iron plate or galvanized-iron wire rope must be used, or the copper plate and connecting wires well tinned, on account of the poisonous character of the salts formed on the copper conductors.

COST OF GARBAGE REDUCTION.

The engineer in charge of the design and construction the garbage reduction plant built for the city of Columbus, hio, has just issued his report for the first year of opera-n. An abstract of the report is published hereafter:

A review of the history of the plant and a brief descrip-n of it is given, which states, among other things, that e city advertised early in 1908 for bids for the construction a reduction plant to be built in accordance with specifica-ns issued by the city, but no bids were received. The ecifications were at once revised and two bids were receiv-, but both rejected, because the lowest, $230,000, was con-dered too high. The Board of Public Service then decided at better results could be obtained by employing an en-neer to design and construct the plant so they could award ntracts on separate parts of the work, and Mr. Osborn was ployed for this work in July, 1908.

A reduction plant was designed with a capacity of dis-sing of 80 tons of garbage in 12 hours; this capacity be-g considered sufficient to take care of the future growth of e city for a number of years and at the same time provide any emergency in case of breakdown. Contracts for chinery were awarded in November, 1908, and this and e buildings were nearly completed by the latter part of 09, when winter shut down the work. The plant was com-eted and placed in operation on July 20 of the following ar and has been in continuous operation ever since.

At the same time the plant was being constructed, col-tion equipment and various buildings were being provid-

On a six-acre plot in a comparatively central location re built a garbage loading station, garbage collection ble, railroad sidings, dog pound, night soil station, street pair yards, wagon sheds and blacksmith and repair shop; ile work is now under way for the erection of a stable for e street cleaning department.

The dog pound consists of a small one-story frame ilding with an office in front and stalls for keeping dogs til released or otherwise disposed of. The nightsoil tion consists of a small one-story brick building contain-g a concrete basin in which the wagon tanks discharge eir contents, which is then diluted with water and flushed o the sewer. The stable is a two-story building 60 feet de by 200 feet long. Stalls are arranged in rows across e building, with a ten-foot passage aisle at the rear and a ır-foot feeding aisle at the front. A centre aisle 8 feet de runs the entire length of the building. The stable has capacity of 160 horses, and the ground room also contains rness rooms and the office of the stableman. The second or is used for storage of feed and also contains the office the superintendent of collection and a locker and bathroom the men.

The garbage loading station consists of a two-story brick ilding 40 feet wide by 90 feet long, with railway tracks tending through it. The wagons are driven up an incline iveway onto the second or loading floor which is about 15 et above the railway track. The wagon is backed up to bumping rail and the front end of the wagon body elevated th power hoist, thus discharging the garbage into the car low. The building houses two cars at one time when the rge double track doors are closed, so that all work of load-g is done inside the building. Four garbage cars were rchased for transporting the garbage to the disposal plant. ese cars were especially made, having a steel semi-circular dy set on trunnions so that they can be turned to dis-arge the load. The cars have a capacity of 80,000 pounds 1,400 cubic feet of garbage.

Thirty-four garbage wagons were purchased for use in collection. These wagons were built according to the city's specifications and consist of rectangular steel bodies mount-ed on heavy running gears. The wagons are provided with spring seat, and canvas covering put on in sections. The sectional canvas cover makes it necessary to uncover only a part of the wagon at a time and at the same time does away with the noise caused by metal covers. The wagons have a capacity of 2½ cubic yards and the net weight of the loads varies from 1½ to 2 tons.

The loading station and other buildings described above are placed at a comparatively central point in the city, on the Scioto River. The reduction plant is located about 1½ miles south of the city limits, also on the bank of the river. The plant consists of four buildings—the green garbage or unloading building, the main or reduction building, the office and a small stable. A car of garbage, when delivered at the plant, is weighed on railway track scales and then run into the green garbage building on a railway siding which extends through it. The body of the car is then turned on trunnions by means of power hoists and the contents of the car discharged onto the floor below. Here the free water is drained off through a gutter covered with perforated plates which extends the full length of the building. The water so flowing off is drained into a catch basin from which it is discharged into grease separating tanks. The garbage is sorted and shoveled into a 24-inch scraper conveyer which extends the full length of the green garbage building.

Connecting the green garbage building with the main building is an inclined truss which carries the conveyer to the top of the latter building, where it discharges the garbage through swivel spouts directly into the digestors. When the garbage has been cooked in the digestors it is discharged through a large valve into a receiving hopper and from this to a roller press. The vapors which arise from the mass when dropped into the hopper are conducted to a condenser which in turn is connected to a vapor-tight steel hot well. The time required in cooking varies with the quality of garbage, but averages from 6 to 8 hours with the steam at from 60 to 70 pounds gauge pressure as it enters the digestor.

After passing through the presses the compressed material is carried to the drying department, where it is fed into a revolving cylindrical dryer. After being thus dried the material is passed through a revolving screen and the screened tankage is placed in vacuum mixing driers, together with the concentrated syrup from the evaporator. The dry fibrous material acts as a filler and enables the moisture in the syrup to be driven off. The addition of the syrup to the fibrous tankage provides a higher grade of tankage from a mechanical and fertilizing standpoint. When this mixture has been dried it is conveyed by a spiral conveyer and an elevator to the third floor where it is stored until shipment.

The water and grease from the press flow through a conduit to the grease separating room. The grease drained off from the separating tanks is heated in the treating tanks in order to separate out the impurities, and is then pumped into storage tanks ready for shipment.

The tank water drawn off from the grease separators is evaporated so as to recover the five to seven per cent. of solids in solution. An evaporator is used consisting of three pans, capable of concentrating 1,500 gallons of tank water per hour from 7 degrees Be. to 22 degrees Be., using exhaust steam at five pounds pressure and a vacuum of 25 inches on the third pan. The concentrated syrup is drawn off by a magma pump and discharged into a storage tank, to be added to the tankage as previously described. The feed pump to the evaporator is provided with a neutralizing gear and connected to a tank containing a neutralizing solution; thus

securing the mixture with the tank water of the amount of solution required to neutralize the acid so as to prevent its attacking the metal.

The city now has under construction a percolating plant to be used in extracting grease from the dry tankage, as only about one-half of the available grease is recovered by means of the press. The percolating plant will consist of an extractor, vaporizers, condensers and storage tanks.

The electric current for both lighting and power is furnished by the municipal lighting plant at 1½ cts. per kw.h. An independent motor is connected with each power-driven unit and operated with 440-volt, 60-cycle, two-phase current. The boiler plant consists of three horizontal tubular boilers 78 inches in diameter by 20 feet long. Two of the boilers are in regular service and the third is in reserve.

The cost of the collection equipment and of the reduction plant was as follows:

Collection Department.

Loading Station site	$10,136.40	
Loading Station	14,101.64	
Collection Stable	41,796.55	
Trestle and driveway	2,153.10	
Grading, fill, electric wiring	2,379.54	
Garbage cars	7,564.00	
Garbage wagons	7,151.10	
Railway siding	3,161.60	
		$ 88,443.93

Reduction Plant.

Levee	$ 9,711.72	
Buildings, grading, etc.	81,267.05	
Reduction machinery	59,866.00	
Power equipment	21,356.70	
Railway tracks	3,342.80	
Conveying machinery	9,316.22	
Electric wiring	3,670.99	
Non-conducting covering	1,010.75	
		$189,542.23

Miscellaneous.

Office and advertising	$ 1,401.18	
Engineering	16,143.48	
		$ 17,544.66
Total		$295,530.82

As during the first six months of operation, that is the last six months of the year 1910, the works were new and the men unacquainted with operating them, Mr. Osborn has taken the first six months of 1911 as more representative of what results can be obtained. During this period accurate records were kept of the operation and the cost computed for each part of the operation. During the first half of 1911 the amounts of garbage disposed of each month were as follows:

January	1,063.08 tons
February	977.64 tons
March	1,114.75 tons
April	1,175.22 tons
May	1,364.05 tons
June	1,371.39 tons
Total	7,066.13 tons

The above includes 94 dead horses and 9 cows.

The plant was operated 153 days, and the average tonnage per day was 45.59.

As the plant has a capacity of 160 tons of garbage in 24 hours, the disposing of 45.59 tons per day was done ordinarily during one eight hour shift. During the remaining shift only such work was done as required more than eight hours. If the tonnage of garbage was sufficient to operate the plant at full capacity the cost per ton would be decreased, as the same number of men are required to operate the machinery irrespective of the tankage to be disposed of.

The receipts of the works from the products were as follows:—

206.48 tons of grease	$21,413.92
1,132.03 tons of tankage	10,338.42
62 hides	253.90
Miscellaneous	1.50
Total	$32,007.74

In addition to this there was on hand June 30, 1911:

43 tons of grease @ $100.00	$4,300.00
156.34 tons tankage @ $10.00	1,563.40
34 hides @ $4.00	136.00
Total	$5,999.40

The inventory of January 1, 1911, was:

68.44 tons grease @ $108.00	$7,391.52
100 tons tankage @ $10.00	1,000.00
Total	$8,391.52

This makes the net receipts from by-products recovered from 7,066.13 tons of garbage to be $29,615.62.

Each carload was analyzed for determining both the fertilizing elements (on which the price per ton is based) and also the percentage of grease left in the material, these analyses showing this percentage of grease to be approximately ten. It is believed that if the percolating plant which is now under construction had been in operation, a recovery of 8 per cent. of grease would have been made, which would have amounted to 95 tons, valued at $9,500. The operation of the percolating plant would have required an additional expense of $2,000, leaving a net revenue from this plant of $7,500. The total cost for the collection of garbage for the first six months of 1911 amounted to $17,794.99; so that, with the percolating plant operating, the receipts from garbage would have been $4,313.44 over and above the cost of collection and disposal.

The total expenditures for the six months were as follows:—

Supervision and payrolls	$9,724.03	
Coal	2,349.75	
Electric power	843.90	
Repairs and renewals	849.24	
Supplies	548.13	
Office expense	185.78	
Miscellaneous	191.84	
Unpaid bills July 1st, 1911	839.52	
		$15,532.19

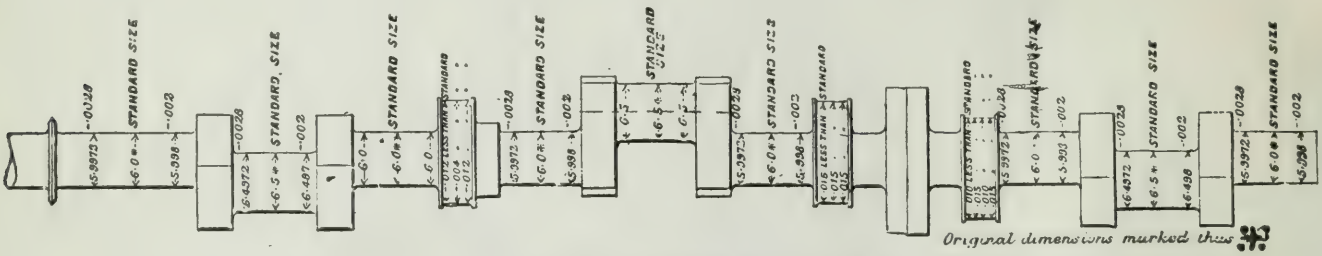
Inventory coal and supplies, July 1, 1911:

250 tons coal @ $1.30	$ 325.00	
Pipe, fittings, supplies, etc.	200.00	
		525.00
Total net cost of disposal		$15,007.19

This leaves a difference between receipts and expenditures of $14,608.43. As 7,066.13 tons of garbage were disposed of, this shows a net revenue per ton of garbage of $4.19, a net cost per ton for disposal of $2.12 and a profit per ton of $2.07.

THE WEAR OF MACHINERY.

How nearly forced lubrication can produce and maintain the ideal condition of confining all the wear to the oil is shown by the engraving on this page, which records the original and present dimensions of a three-throw crank-shaft, which had been at work for seven years. We are indebted for this information to A. L. Mieville, resident engineer for Canada, of Messrs. W. H. Allen, Son & Company, Limited, of Bedford, England, who designed and built the engine, and which firm is represented in Canada by Chapman & Walker, Toronto. It was intended to develop not more than 200 horse-power, with an occasional overload; but for seven years it has run for 12 hours a day and 300 days a year at considerable overload, the rate of revolution being 300 per minute. After all this long and arduous work the wear in many places is not capable of being measured, and in all



Sketch of Shaft, Showing Original and Present Dimensions.

other parts is merely microscopic, it being a noteworthy feature that all the bearings remained cylindrical.

The crank-pins are all 6.5 in. in diameter, and all journals are perfectly round, and in all three cases this diameter has suffered no diminution in the centre. The ends, however, in two cases have been reduced a little, the smallest figure being 6.4972, a wear of $\frac{28}{10000}$ in. The bearings were originally 6 in. in diameter, and in one case there is no measurable diminution. In all cases the bearings have kept their original dimensions in the centre, there being in most of them a slight wear towards the ends, the smallest diameter in the six bearings being 5.9972 in., a reduction of $\frac{28}{10000}$ in. The eccentric sheaves, with their rapid surface motion, have suffered more, but in these cases the largest reduction is $\frac{15}{1000}$ in.

One lesson taught by these measurements is that lubrication only fulfils its ideal purpose of absolutely preventing wear when it is perfect. The oil is led to the centre of the bearings, and at that point it absolutely keeps the metals apart. But towards the ends the film falls off slightly, with the result that there is some wear, although it is so small that it is of no account, being nowhere over $\frac{5}{1000}$ in.

Here we have a crank-shaft 13 ft. long, with three crank-pins and six bearings, and conforming so closely to its designed dimensions that instruments measuring to the ten-thousandth part of an inch cannot detect a difference at any part. And, thanks to the care and skill applied to the lubrication, many of these dimensions have suffered no change after seven years of hard and constant work. Such results can only be attained by the modern tools, coupled with splendid management and organization.

Over 19,000,000 square yards of bitulithic paving have been laid during the last decade in Canada and the United States.

LOCH LEVEN HYDRO-ELECTRIC INSTALLATION.

In the course of his paper before the Institution of Civil Engineers of Great Britain, on the Loch Leven Water Power Works, Mr. A. H. Roberts, M.I.C.E., said the Loch Leven Water Power Acts were obtained in 1901 and 1904, authorizing the construction of works to utilize the rainfall of the western slope of Rannoch Moor for power for industrial purposes. The scheme possesses a number of advantages, including large catchment-area, heavy rainfall and high head, all in proximity to the seaboard. The author refers to the usual waterworks practice of reckoning only upon the mean rainfall of the driest three consecutive years, and suggests that in power-schemes of this character it might often be possible to obtain a greater output of power with the same expenditure. This could be effected by installing extra units of power plant (turbines, etc.), making a reduction in the height (and therefore in the cost) of the storage dam, and arranging to work the extra power in wet seasons.

The catchment-area for the Loch Leven Works is the basin of the River Blackwater, and is 55 square miles in extent, lying between Lochs Treig, Ossian and Rannoch and Glen Coe. Rain-gauges established in 1905 and 1906 have given average readings of over 70 in. for Blackwater basin and 80 in. for Kinlochleven. No compensation-water had to be supplied, this feature greatly increasing the available power. The site of the reservoir is favorably contoured for storage purposes, and the full reservoir is about 7½ miles in length and ½ mile in breadth. Its greatest depth is 75 ft., and it impounds over 20,000 million gallons of water. The Blackwater dam is 3,112 ft. in length, with a maximum height of 86 ft., its top surface being 1,068 ft. above Ordnance datum. About half its length is formed as a waste-weir in six horizontal steps of 6 in. each. The foundation is of an exceptionally sound character; only a few feet of the surface beds had to be removed to obtain a satisfactory foundation. The plant and materials required for the construction were brought by sea to the wharf and carried thence to the dam, etc., by an overhead cableway and an overland railway of 3 ft. gauge, which latter included two rope inclines. The cableway was driven by a Pelton wheel at the foot of the Falls of Leven. The dam is built of large blocks of stone embedded in a matrix of ordinary concrete, with fine concrete facework. The bulk of the cement was of rotary-kiln manufacture, and exhibited certain characteristics, which are described. Cracks due to the contraction of the concrete appeared after the dam was built, traversing it vertically from top to bottom. Reference is made to the question of inserting contraction-joints in large dams. The valve-tower contains the six valves of the three draw-off pipes, the spindles being carried up to the valve-house above top water level. The draw-off pipes lead to the upper penstock-chamber, whence the water is delivered over a measuring-weir into the conduit.

Water is conveyed to the pipe-track by this conduit, which is 3½ miles in length; it is of square section, 8 ft. by 8 ft., and is laid to a general gradient of 1 in 1,000. The construction consists for the lower part of a channel excavated in the rock and lined with concrete; while the work above rock level is of concrete reinforced with expanded metal and round bars. Expansion joints are inserted in the walls at intervals of 64 ft. Contraction cracks, however, appeared midway between these joints until the conduit was brought into use, after which they closed up entirely. The arrangements for the maintenance of the natural surface drainage are described, and also the methods of shuttering and concreting the work. Along the route of the conduit and above the same lies a catchment-area of 3½ square miles, with a rainfall of about 75 in., the greater part of which is drained by three streams. These have been laid under contribution by collecting their water and turning it into the the conduit. A description is given of their intake works and of the automatic valves for throwing off superfluous water. Electrical transmitters and recorders indicate to the valve-keepers at the lower penstock-chamber the changes taking place in the contribution of the side streams, enabling them to take advantage of the extra water and reduce the draw-off from the reservoir, thus storing an equivalent quantity of water in the reservoir. The conduit discharges its water into the lower penstock-chamber of about 300,000 gallons capacity, where it is measured and delivered to the pipes as required.

From the penstock-chamber water is conveyed to the power-house in six welded steel pipes of 39 in. diameter. The track is 1¼ miles in length, and the fall of 935 ft. yields a normal static pressure of 406 lbs. per sq. in. Pipes are supported upon concrete pedestals, and at the bends there are heavy concrete anchorages to resist the thrusts of the water and pipes. The pipes are made from one plate welded longitudinally, and vary in thickness from 10 millimetres (0.394 in.) at the top of the hill to 22 millimetres (0.866 in.) at the foot. With the exception of flange-joints in special positions the whole line is jointed with a special "muff" joint, a form of spigot and socket with joint rings for securing the packing material. Expansion is thus accommodated at every joint. The pipes were brought to the site by an overland railway laid up the hill alongside the track, and were lifted into position by specially-adapted derrick-cranes. Water is distributed from the six main pipes to the various turbines by a system of pipes comprising two omnibus pipes and six feeders, all of 39 in. diameter. Each "bus" pipe with its three feeders forms one complete system, the two systems being at different levels to enable branches to cross. One branch from each bus pipe feeds each turbine. The main valves which control the supply of water to the distributing pipes are of ordinary sluice-valve type, but specially designed to meet the combination of large diameter and high pressure. They are hydraulically worked, and are fitted with operating gear and automatic closing appliance, together with a mechanical device for controlling the speed of closing. At the top of the pipe-track, immediately below the penstock-chamber, automatic cut-off valves have been installed, of the usual "butterfly" pattern, to stop the flow of water in the event of a burst occurring on the main pipe-lines. At the summit of a slight elevation in the main line air-valves have been fixed of a special design to allow large quantities of air to pass in or out, as required, when filling or emptying pipes. The tail race is of concrete, the channel leading to an outfall in the River Leven.

The company have constructed a wharf and a jetty, both of timber, in Loch Leven; and have dredged a channel through the Loch Leven Narrows. A domestic water supply has been installed for the village and factories of Kinloch-leven. It comprises a storage-reservoir with [illegible] in a neighboring valley, pipe-line, a service reservoir of reinforced concrete, and distributing mains. The dam at present is only carried up to half its ultimate height, but when completed will be 55 ft., and its length will be 440 ft. Contraction-joints are provided, and have proved efficient in preventing the occurrence of cracks.

The works have cost about $3,000,000, and are now the property of the British Aluminium Company. The construction was begun in August, 1905, and the factory commenced working in February, 1909. The engineers were Messrs. Thomas Meik & Sons, and Messrs. Kennedy & Jenkin in collaboration with Mr. W. Murray Morrison, the manager and technical adviser of the company. The principal contractors were Sir John Jackson, Ltd., and there were other subsidiary contracts. Mr. A. H. Roberts was resident engineer.

RETROGRESSION IN TENSILE STRENGTHS OF CEMENT.

At a meeting of the American Society of Civil Engineers, held in New York on November 15th, J. M. O'Hara, Assoc. M. Am. Soc. C.E., read a paper on the above subject. After taking up the specification for Portland cement adopted by the American Society for Testing Materials, which require no retrogression in strength between 7 and 28 days, the writer goes into an examination of the question as to whether or not retrogression is an indication of poor quality. Summarizing the principal ingredients of Portland cement and the action of the various chemical ingredients, he gives tables to show the action of American and European Portland cements at various periods between 7 days and 12 months, as well as the action of gypsum upon cement, and comes to the conclusion that the retrogression is probably due to calcium aluminates. He goes on to say: "The first strength is obtained from the calcium aluminates, as they hydrate quickly but the permanent strength is due to the calcium silicates, which are much slower in hydrating. The full tensile strength of the calcium aluminates is reached at one month, when they become more or less inert; at this age the calcium silicates are acting slowly, but are not strong enough to maintain the strain already reached by the calcium aluminates, hence retrogression takes place. The calcium silicates are constantly increasing in strength for an indefinite period, and gradually pick up the lost strength."

From the above he concludes that "if the action of the calcium silicates can be accelerated, so that the final strength is reached sooner, it is an advantage, and that this can be done in the case of American Portland cement by grinding the materials much finer and carrying a higher calcium silicate factor. The fine grinding accelerates the hydration of the calcium aluminates and silicates so that great strength is likely to occur at the 7-day period, and little or no gain, or even retrogression, at the 28-day period."

From this the writer proceeds to a table showing retrogression between the 7 and 28-day periods at intermediate dates at 10 and 20 days, and from this he argues that as this retrogression in many cases escapes detection by reason of the fact that the cement briquettes are only broken at 7 and 28 days, it is difficult to say that a cement giving these results is fit for use if one showing retrogression should be rejected.

The paper was discussed by a party of engineers who took the opposite side of the question, claiming that retrogression was an indication of defective manufacture and of inherent defects in the cement itself.

WIND PRESSURE AGAINST INCLINED ROOFS.

Experiments to determine intensity of wind pressure gainst inclined roofs were conducted during 1910 and 1911 y Mr. H. P. Boardman, of the faculty of the University of Nevada at Reno. He has compiled the results of his investigations in a paper presented on December 6 before the Western Society of Engineers, from which the following notes have been taken:

In these tests it was desired to approximate as closely s possible the conditions that exist in an ordinary building. To do this the model house as shown in diagram in Fig. 1 vas built. The house was 10 ft. long with hinged roof and o projecting eaves, and was open on the leeward side. hrinkage had developed some cracks in the walls, but an nemometer, held inside the house while the wind velocity vas considerable, showed very little motion and no definite

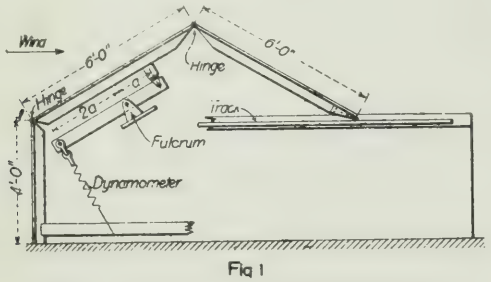


Fig. 1.—Diagram of Testing House.

irection to the air within. The two roof surfaces were overed with prepared waterproof roofing, and the gable nds closed with galvanized iron sheets, so hung as not to nterfere with adjusting the roof. The adjusting was accomplished as shown in Fig. 1 by means of small grooved heels supporting leeward roof and traveling on tracks as ndicated. Small canvas curtains weighted with iron rods t the lower edge covered the opening along the windward aves and ridge. The house was so mounted as to rotate hrough an arc of 60° in order to face the direction of wind. This was achieved by means of the centre post of the windward face acting as centre of rotation and three other posts oward the rear of the house with small wheels traveling on wooden track. The prevailing winds are from the west, nd the house was so placed as to command an unbroken vestern exposure to them.

The method of measuring the wind pressure against the oof was by means of a lever and spring dynamometer as hown on the diagram in Fig. 1. Standardizing the spring ynamometer gave a result of 144 lb. per inch of compresion of spring, on dynamometer scale. Assuming the pressure normal to the roof to be uniformly distributed over its o sq. ft. of area, the value per square foot is found by the ormula

$$Pn = (s—d) \times 144 \times 2 \times 4) / (60 \times 3)$$
$$= 6.4\ (s—d)$$

where

Pn = normal component of wind pressure in pounds per square foot against an inclined surface.

s = dynamometer reading in inches at time of wind load.

d = dynamometer reading in inches due to dead load alone. An anemometer was used for measuring velocity of wind.

The method of taking observations was as follows: An bserver stationed about 20 ft. to windward of the centre of he house held the anemometer at an elevation approximately equal to that of the centre of the roof surface. The inside observer watching the dynamometer signaled to the outside observer the time for starting the test, at the same time starting a stop watch; when dynamometer reading materially changed he signaled the outside man and stopped his watch. The outside observer had meanwhile automatically recorded the speed of the wind during the time interval of test, by means of a stop catch lever controlling the dial pointer of the anemometer without influencing the vanes. The estimated reading of the dynamometer, the duration of test and anemometer reading are then recorded.

Testing the anemometer used for possible inaccuracies it was found that the readings were too low for velocities below 12.8 ft. per second, and too high for those above that speed. The diagram, Fig 2, gives a graphical method of applying this correction and expresses the corrected velocities in miles per hour.

Individual velocities were first reduced by the formulas $V = 15\ v\ /22$ and $Pn = 6.4\ (s—d)$ to get values of V and Pn. The values for V were further corrected by means of the diagram in Fig. 2, and such values as fell within the range of 1 mile per hour, e.g., between V = 10 and V = 11. were averaged and plotted as abscissæ, with corresponding averages of Pn as ordinates. In some cases individual observations were plotted, and for higher velocities than about 18 miles per hour values of V showing a range of 2 miles an hour or even higher were averaged. It was observed that all high velocities came in gusts, lasting from a fraction of a second to 10 seconds, but few recorded tests were for less than 2 or 3 seconds.

A series of observations by Mr. Sears and Mr. Miller with velocities not exceeding 20 miles per hour, when plotted, showed, for small angles of slope, the points grouped closely along straight lines, the slope of the lines increasing as the angle of inclination increased. This, according to the author, would indicate less pressure at high velocities than expected. Mr. Boardman's personal observations covered a range of roof inclinations from 40 to 70 deg. with velocities as high as 50 miles per hour. Several observations were taken at 70 deg. as pressure at that inclination should closely approximate that against a vertical surface. Negative pressures were obtained at low inclinations and

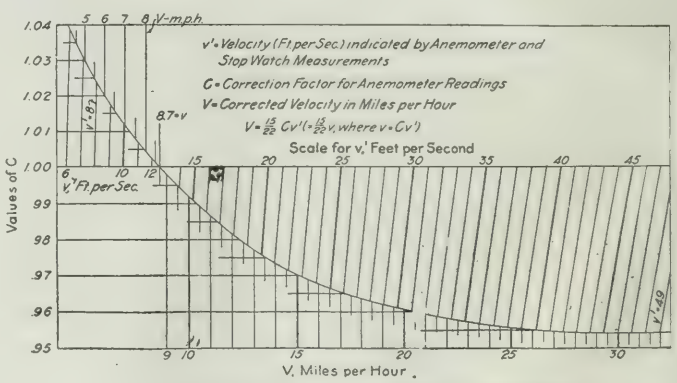


Fig 2.—Diagram of Anemometer Corrections.

explained as follows: The wind deflected upward by the windward surface of the roof tends to draw with it, and thus rarefy, the air over the leeward surface, thus permitting the air within the building to press upward sufficiently to produce a negative pressure.

In his discussion of results Mr Boardman states: The results of tests by Mr. Sears and Mr. Miller seem to indicate a straight line formula, as the relation between Pn and V for each inclination of the roof, and this appears to be further justified by those of later tests, notably at inclinations of 40 deg. and 70 deg., the positions at which maximum velocity was recorded. Hence a series of empirical formulas

of the form Pn = a V + b were deduced from plotted observations at inclinations of 15 deg. and from 20 deg. to 70 deg. inclusive, at 10 deg. intervals, by the selection of average lines through the points plotted.

In order to determine the relation at any given velocity between Pn and the inclination of the roof surface, the values of Pn were computed for velocities of 10, 30, 50 and 100 miles per hour, and for inclinations ranging from 15 deg. to 70 deg. by the straight line formulas above mentioned and plotted in Fig. 3. In the selection of average lines, consideration was given to the resultant effect on curves of Fig. 3, as it appears there should be some regular law of increase in pressure with increase in angle of slope. It is to be noted that results of tests at 40-deg. slope when plotted would not give consistent points in Fig. 3, for the respective velocities, but fell below. No explanation is offered for this discrepancy, especially as results of the last tests made at 40 deg. inclination gave the most definite location of any, to the average straight line.

Since the pressure produced when V = 100 miles per hour is the commonly accepted maximum used in designing, a formula was computed on the basis of V = 100 to fit the points plotted in Fig. 3. In deriving this formula it was assumed from the appearance of the curves that the equation would be parabolic with its vertex on the vertical, through 90 deg. inclination. The general equation of the parabola

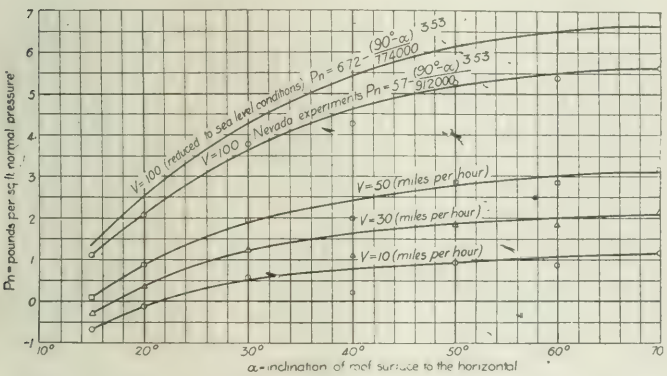

Pn = pounds per sq. ft. normal pressure
α = inclination of roof surface to the horizontal
V=100 (reduced to sea level conditions) Pn = 6.72 − (90°−α)^3.53 / 774000
V=100 at Nevada experiments Pn = 5.7 − (90°−α)^3.53 / 912000
V=50 (miles per hour)
V=30 (miles per hour)
V=10 (miles per hour)

Fig. 3.—Relation Between Wind Pressure and Slope of Roof.

with its origin at the vertex is $Xn = Ky$ where n is an unknown exponent, and K an unknown coefficient. Hence n log x = log y + log K or log y = n log x—log K, which are typical equations of the straight line.

Assuming a value of Pn as the vertex of the parabola and passing this curve through two other points, we have two values of x and two of y, with corresponding values of log x and log y. From these either graphically or analytically the constants n and log K may be obtained. By trial we select Pn = 5.7 as the vertex, and expressing x and y with reference to the origin at the vertex we have: x = (90 deg. α) and y = (5.7—Pn) where α = 9 α deg. For other points, assigning values to x of 40 deg. and 70 deg., and y = 0.5 and 3.6; we have α = 50 deg. and 20 deg. and Pn = 5.2 and 2.1. Passing a curve through these points and the vertex we obtain the following equation: $x^{3.53} = 912{,}000\ y$ or $(90 \text{ deg.} - \alpha)^{3.53} = 912{,}000\ (5.7 - Pn)$. Solving for Pn gives $Pn = (5.7 - y)$ or $Pn = 5.7 - (90 \text{ deg.} - \alpha)^{3.53} / 912{,}000$. This equation plotted is shown in Fig. 3. Since the atmospheric pressure at sea level is about 18 per cent. greater than at Reno it was assumed that wind pressure would be correspondingly greater and the equation $Pn = 6.72 - (90 \text{ deg.} - \alpha)^{3.53} / 774{,}000$ was derived on that basis. This equation, plotted, is shown in Fig. 3 as adapted for general use.

NOTES ON THE THEORY AND PRACTICE OF PERCOLATING FILTERS.*

By J. E. Farmer, F.C.I., Sewage Works Manager, Croydon.

Before anything new can be put into practical form, the mind must have been at work, and worked out certain details, also the expected results.

How and when the idea entered the mind of the first one to put into practice the percolating method of sewage purification I cannot say, as I have not seen any definite record of the event. It was probably brought about by the action of rain falling on porous soil, and the purification effected by this means. The means of imitating the dropping of rain for the spraying of the sewage on the surface of the filters I do not intend going into in this paper, as they are well known. The theory of the percolating method of filtration is that when a foul liquid is passed over a surface, such surface becomes coated with the purifying agent necessary for the purification expected. In practice it is known that by this means purification is effected, but the simple theory as mentioned is only a portion of that required to explain the whole working of a filter. By allowing the foul liquid to flow over a surface one obtains certain results: it is quite natural the mind would work on the questions of the cause and also on probable improvements.

One factor that comes to one's mind on considering the theory is that of surface area. It would be expected that if the area were increased, greater purification would be effected. This is proved by the greater purification given by a clinker filter than one of gravel, the grade and quantities being equal.

On comparing the surface area of a material of different sizes, it is seen that with the same mass the surface area can be increased considerably.

Taking a 1 ft. cube measure, which would hold one sphere of 1 ft. diameter, containing 904.78 cub. in., it would have a surface area of 452.39 sq. in., but the same measure would hold 1,728 spheres of 1 in. diameter, the total area being 5,428.6 sq. in., and the mass 904.78 cub. in., the same mass as the sphere of 1 ft. diameter, but with twelve times the surface area.

Another factor that must be taken into consideration is the size of the space left between one particle and another forming the body of the filter. If the size is too small, the friction is too great for the proper passage, in the downward direction, of the solid matter, also for the movement of the air.

Taking the same measure and spheres as above, the size of the spaces, with 1 ft. diameter sphere, would be 205.8 cub. in. each, and with 1 in. diameter 0.48 cub. in.

These calculations being made from mathematical figures, the results are more correct than those which can possibly be obtained in practice, but they are useful in giving an impetus to the mind to work out an ideal filter.

In the theory as mentioned the following conclusions are arrived at:—

(1) The smaller the particles comprising the filter, the greater the surface area.

(2) The smaller the particles comprising the filter, the smaller the individual space between the particles.

In my opinion, these two conclusions have a great bearing on the construction of a filter, when the work expected to be done is taken into consideration—namely, the

* Paper submitted at a meeting of the Association of Managers of Sewage Disposal Works at Croydon.

oxidation of the matter in suspension and the purification of the liquid. If the space between the individual particles is of such a fineness that the resistance to the passage of the solid matter is greater than the accumulation rate, choking is the result, also ponding of the surface.

The capacity of the interstices can be decreased, not only by using smaller material, assuming it is all one grade, but by mixing a small grade and a large together. This is apparent when the capacity of the interstices of any given grade of spheres is taken; for instance, 1-in. sphere—a cube foot would take 1,728 spheres of at least ⅜-in. diameter, and reduce the total capacity of the interstices from 832.22 to 775.5 cub. in., would but increase the surface area from 5,428.6 to 6,191.8 sq. in. The remaining interstices would still take a sphere of about 1/16 in. diameter, and still further increase the surface area, but with a lessened interstical capacity.

It is obvious that to increase the surface area by so mixing the grades, the resistance to the passage of the solid matter and air is increased.

A general conclusion of the foregoing is that the following are factors that must be taken into consideration before determining the grade of material to use:—

(1) Quality of the sewage liquid required to be treated.
(2) Quantity required to be treated on any given area.
(3) The degree of purification required.

In practice many materials are used, because of their cheapness or proved suitability. Clinker is the material mostly used, as in thickly-populated districts it is a by-product from the manufacture of products that have become necessitous with the rise of civilization. In other places gravel, waste from potteries, and so on, is cheaper, but cheapness should not altogether be taken as the main reason for the use of any particular material, as it may not have the properties required to produce the desired purification. Clinker has the advantage over many materials in having a large surface area for its mass, and so is very suitable, giving a greater degree of purification than smoother-surfaced material.

A material may be composed of such different-sized particles that when not graded the interstices may conform to that which is required for the filter; but care must be used, as the obtaining of a solid mass, as in the mixing of materials for concrete, is to be avoided, that which is to be kept in mind being maximum surface area with the maximum interstical volume. To obtain these maxima, clinker is generally used, and the filter built up in grades, the larger size at the bottom decreasing in size to the top.

By having the small-sized material at the top, the surface area per cube unit is greater than the lower depth, thereby arresting the solids on the surface layer of the filter, where it can obtain a greater amount of oxygen than lower down the filter.

The advantage of having the larger material at the bottom of the filter is the increased drainage effected, as the resistance through friction is much less than it is with the top layer of small material.

Experience has proved that good drainage of the lower portion of a percolating filter is absolutely necessary, and to obtain the best results a smooth-surfaced material, such as gravel, is found to be the most efficacious.

There are many things connected with sewage purification that require elucidation before it can be said to be on a strictly scientific basis; but with the combination of the labors of all those working on the subject, and patient investigation by those working every day on the purification of sewage, this subject may in the future be on as much a scientific basis as many of the industries are to-day.

One who sees a filter every day notices that there are many changes taking place during a year. For instance, at times the surface is covered with a dirty, greyish-colored growth. After a time this gives place to a greenish-colored growth; at another period there is no growth perceivable; sometimes the various growths are in varying-sized patches; also, the amount of humus matter being discharged increases suddenly, and the degree of purification at times is unaccountably affected.

To find out the cause and effect of these changes will no doubt help forward the solving of the problem of sewage purification, and assist in placing it on a scientific basis, so that any sewage works manager who has the courage to tackle the investigation of any one of the changes that goes on in a percolating filter will have his patience well tried, and if successful will be rewarded with the pleasure of having attained something towards building up the science of sewage purification.

Where, as in most instances is the case, the expenditure in the construction of the filters is limited, it is much better to spend money on that portion necessary for the purification, such as the distribution, filtering media, and drainage, than on having artistic walls, as, no matter how pleasant to the eye a set of filters may look, if they do not do the work expected of them, the manager does not derive much benefit from the artistic appearance.

Sewage purification, as regards the liquid portion, has got to such a pitch that, provided the money is forthcoming, any degree of purification can be attained; but the question in my mind is, Can the the same purification be obtained with less expenditure or can a greater quantity be purified with the same purification and the same expenditure?

RUSTING OF IRON.

Wrought-iron work, if not properly cared for in respect to painting, or under conditions otherwise bad, may be expected to rust at a rate which corresponds to the loss of ⅛-inch on each surface for from fifteen to thirty years; but with proper care as to painting, and exclusive of exceptionally bad conditions, it does not appear to waste at any measurable rate. In some instances, upon scraping the paint from girders which had been in use for thirty years, the writer has found, beneath the original red lead, the metallic surface, brigh and clean, showing no trace of rust. Of ordinary steel work the same cannot be said, the common experience being that mild steel is very liable to be attacked by rust. With common care in the bridge-yard during manufacture, such that with wrought iron no after trouble would be noticeable, steel is very liable to show, within a year of being built up, numerous little blisters on the painted surface; any one of these being broken away discloses a small rust-pit. This is more often seen on the flange surfaces (horizontal) than on web surfaces (vertical), but it is probable the position has little to do with the matter, and that it is rather due to the fact that rust has been earlier started on the flange-plates, upon being put through the drilling machines and inundated with slurry, which occurs only to a more limited extent with webs having fewer holes. The heads of steel rivets do not show this tendency to "pit" or to early development of rust. The riveting is about the last operation in making a girder, each rivet being freed of all rust by heating, and quickly coming under the protection of oil or paint.

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ENGINEERING OUTLOOK FOR 1912.

The past year has been an active one for the construction engineer and the contractor. Never before in the history of Canada has there been so much money spent in one year on the extension of railways, installation of water plants, construction of sewerage systems, the erection of bridges, large factories and office buildings as was expended during 1911.

In the Annual Statistical Review of The Monetary Times Mr. E. A. James in a comprehensive manner analyzes the prospects for 1912.

The business activity and expansion have not yet reached in Canada their greatest activities, and, as 1911 exceeded 1910 in this regard, so will 1912 exceed 1911. In the past we have been an agricultural country. Our energy has been directed to the opening of the new lands, and, although this has been expensive, yet the returns have been immediate. To-day we are acquiring the solidity of an older community. We are opening high office buildings, developing rapid transportation routes, highly efficient sanitary schemes, large factories and manufacturing establishments, and extending into the urban, suburban and rural communities the telephone wire and electric circuit.

During 1911 the expenditure of public money on construction work in Canada exceeded $300,000,000, and, with the work not yet completed and the prospective work which will probably be carried out, the figures for 1912 will exceed these by at least $50,000,000.

The city of Toronto, for instance, for extension of railways, bridges and electric light system requires $9,000,000, a third of which will be spent in 1912, or on this item alone $7 per person. The Ontario cities and towns generally are but little behind this high average. Berlin will spend $100,000 on a waterworks system; Chatham will spend $40,000 on pavements; St. Thomas will spend $45,000 on waterworks extension; Hamilton will spend $550,000 on waterworks extension, $500,000 on Hydro-Electric distribution system and $180,000 on pavements; Welland will spend $60,000 on pavements and $20,000 on the water system.

In Western Canada the activity is even greater. Saskatoon will spend on pavements $400,000, sewerage system and extension $300,000. Prince Albert is likely to spend on the power scheme $750,000, while the sewerage system will take $200,000 for its extension. Moose Jaw is planning for extension of the municipal work, the figures being $1,000,000.

Winnipeg, which has spent many millions in municipal improvements, requires $1,500,000 for 1912 for: Pavements, $500,000; sewers, $150,000; waterworks, $100,000; walks, $100,000; subways, $600,000. This expenditure is not required for municipal frills and luxuries, but for absolute necessities in a growing city.

The activities of the West are not confined to the prairie provinces alone. The growth of railway mileage in British Columbia, the extension of the Grand Trunk highways, the development of Pacific ports, all require an expenditure of large sums and compel municipalities to press forward improvements.

Cranbrook will complete the sewerage systems at a cost of $100,000. New Westminster, having completed a $1,000,000 water scheme, have now before the public by-laws aggregating $100,000 covering garbage disposal and sanitary measures, and will likely expend this year on pavements at least $100,000.

Eastern Canada showed unusual activity last year, and the prospect for the present year is even better. The increase in the population in Quebec has been followed

by a general demand for improvements, sewerage and lighting schemes, quicker transportation. The opening of new territories by the Grand Trunk Pacific is creating new activity on the both sides of the St. Lawrence.

In the Maritime provinces the activity has not been so great, but the possibilities of these provinces are being more fully recognized, and the development of water power and the opening of new territories by railways is causing unprecedented activity in construction work. In St. John, N.B., the Government and railways will commence spending $1,000,000 on harbor and docks; Halifax, N.S., will spend on sewers $100,000 and on a standpipe for water $50,000. At this port the Intercolonial Railway will commence in 1912 the $1,000,000 deep water terminal.

With these special cases of municipal expenditure and with the knowledge we have of the probable expenditure of the provinces and by the Dominion on capital account we can arrive at a close approximation of the amount of money that Canada will have to borrow during 1912, in addition to the amount of money that will be spent out of current account.

For Dominion purposes	$35,000,000
For railways, electric and steam...	10,000,000
For municipal improvements	64,000,000
For provincial expenditure	60,000,000

To this large total must be added the amount of money that will be spent out of current revenue, an amount equal, if not in excess of the figures given above. Canada is expanding and developing to-day as is no other nation. Her requirements are great, and it is fortunate that her borrowing power has not yet reached anything like its limit, and the Canadian debentures and bonds, whether municipal, provincial or Dominion, are quickly absorbed in the money markets. So long as this is true, the Canadian engineers and contractors will be the important men in the growing community.

AN EXISTING DANGER.

Fire Commissioner Latulippe and Fire Chief Tremblay, of Montreal, have expressed definite opinions regarding fire precautions and regulations in that city. These, they say, are extremely lax, and will bring home the responsibility for fires in cases where buildings are used for purposes for which they are not designed. The fire commissioner says that if the city were more watchful the number of fires in Montreal could be halved. The fire chief describes the present by-laws as farcical. These points were brought out at the investigation into the fire which occurred at the premises of a garage.

Chief Tremblay stated that the building was in no way adapted for a garage, and was not intended when erected to be put to that use. If such a fire had occurred in any of the great cities of Europe under circumstances like this kind, the parties connected with it would have been amenable before the law. The chief also expressed the opinion that the city by-laws in regard to motor garages were useless, and further, that the system of enforcement of the existing by-laws was not sufficient.

At the conclusion of the taking of evidence, Fire Commissioner Latulippe expressed the opinion that a fire like this kind made it clear that if the city authorities were a little more strict in regard to fire rules and regulations, one-half the fires that occurred might be eliminated. He was in favor of a by-law being passed which would render it a penal offence to provide a building that might prove a fire-trap, or to use a building in such a way as was obviously dangerous in view of the fact that it was put to a use for which it was not intended when built. Such a by-law, suggested Mr. Latulippe, should be made to hold liable all concerned in its construction and use, the architect, contractor and the owner, a provision which would result in enhanced care and greater scruples on the part of all concerned, and would thereby materially diminish the heavy fire bill of the city.

These are matters which cannot be left for innumerable adjourned discussions. It is the duty of the Montreal civic authorities to deal immediately with such a serious phase of the fire waste.

EDITORIAL COMMENT.

Motion pictures were used to illustrate work on placing underground conduits and construction work incidental to this in a recent lecture to the Canadian Society of Civil Engineers. This is the first time to our knowledge that motion pictures have been used for such purposes. There is, no doubt, a wide field for their use along these lines, for they afford a most excellent means of showing methods of construction and design.

* * * *

We draw attention in this issue to an address by Mr. D. H. Browne, which was delivered at the School of Mines dinner, Queen's University, recently. In this address Mr. Browne takes issue with the thoughts expressed by Mr. Crane, who has created such a discussion by his attacks on college education. We must congratulate Mr. Browne on his eloquent and closely-reasoned defense, and we publish it with the hope that it will be widely read.

* * * *

Mayor Geary, of Toronto, has received an answer from Mayor Gaynor, of New York, in response to a letter asking Mayor Gaynor to recommend a competent man for the Park Commissionership for Toronto. In it Mayor Gaynor suggests that he has sufficient to do himself to appoint his own Park Commissioners. We would suggest to Mayor Geary that he endeavor to locate a Canadian for this position. The late Park Commissioner Wilson was a Canadian, and received his training in the Queen Victoria Niagara Falls Park. If Mayor Geary will use a reasonable amount of energy in looking around, he will find competent men to fill this position without advertising in another country.

* * * *

The Dominion Power and Transmission Company, which supplies power to Hamilton, Ontario, is again having trouble with anchor ice at their intake. The city of Hamilton was in darkness a couple of nights last week, all traffic on the street railway and suburban lines being tied up also. Similar trouble last year caused heavy losses to the manufacturers and laboring men there. Where hydraulic power companies are so located that there is liability of interruption of such a nature, means should be taken to have a standby in the shape of auxiliary steam power. Power companies with extensive transmission systems supplying widely-spread territories, with many industries and public utilities dependent on them for power, must of necessity take every precaution to prevent interruption of service. And in many cases the auxiliary steam plant is the only sure way.

THE IDOL OF QUICK RETURNS.*

By David H. Browne.†

There are here at Queen's University some 1,200 students, who have come here to spend from four to six years of their life in the pursuit of some definite object. These students will each spend, perhaps five hundred dollars a year, in railway fares, college fees and living expenses, which means that about $600,000 a year is expended by these young men and women. In addition to this they have during this time surrendered their earning power and become non-producers. We will assume that during eight months of the year these young people are idle, and that their earning capacity is $50 a month. This amounts to a monetary loss of at least $400,000 a year. So that I am quite within the bounds of reason when I say that it costs these students at least one million dollars a year to maintain their attendance at this university.

Now, why do they do this? No one pays out money, none devotes his time, his labor, his ambition in this way without hope of recompense. Ask these boys and girls, and they will answer that they do this in order to be successful in life

Success in life. This means two things, greater earning ability and greater enjoyment capability. The end of life is happiness.

Happiness is not mere Hedonism, not the simple pursuit of pleasure for the sake of pleasure. Happiness means the attainment of man's best, highest, noblest desires. We seek for riches, not for the sake of money alone, but for what we can do therewith to further our physical, mental and spiritual welfare. I take it that these students are here at Queen's in order to gain two things, first the ability to attain a higher position in life, and second the capability to enjoy that position when they have attained it.

The first proposition is then that these students came here with the idea that when they leave college they will be able to earn more and to fill higher positions than if they had never attended college.

Is this correct?

I have here in my hand a pamphlet written by R. T. Crane, President of the Crane Company, of Chicago, which is entitled, "The Futility of Technical Schools in Connection with Mechanics and Manufacturing or Electrical and Civil Engineering." This pamphlet and several others along the same line have been widely circulated. They contain a very violent attack upon the technical schools of the United States, and while the Canadian schools are not mentioned, Mr. Crane's arguments are perfectly applicable on this side of the border. It seems to me that these ideas are false, illogical, and dangerous, but in order to show why I thus deny them, it is necessary first to state Mr. Crane's ideas in order.

Quote Mr. Crane's pamphlet on "Futility of Technical Schools" from page 4 "Importance of starting out in life" to page 7 "However as you cannot."

Mr Crane then goes on to show that a graduate of a technical school will go to work for the General Electric Company for two years in the testing department at [illegible] hour, and will then spend two years more in the engineering department at 27½c. an hour, brings the boys to 27 years of age, at which time, as he says, they will be very lucky if they can go out and secure a job at $3 a day.

Mr. Crane's remedy for this is given in his pamphlet, under the caption. Mr. Crane concludes by accusing the college authorities of sharp practice.

Now, Mr. Crane's attack is directed against American technical schools, but it is reasonable to suppose that his arguments are equally applicable to those on this side of the border.

There are, however, some important points upon which our Canadian schools differ from the American. It is customary in the States to carry a course of nine months, even in some cases of eleven months work. On this side our custom is to limit the class work to a period of five or six months, and to allow the boys to spend three or four months of each year at practical work, in the mine, smelter or shop, according to whatever branch of scientific work the boys intend to make a specialty of. It has been my privilege at the smelter at Copper Cliff, to hire a large number of Canadian students during the summer months. The majority of these are hard-working, diligent, intelligent men, keen to grasp a new situation, and manly enough to accept the discomforts incident to the work, in a cheerful way. We are glad to have them there. Those who make good are always welcome again. Of course, as in any other body of men, there are a few goats. I have had a student come to me after a week's work around the furnace and ask for his time, giving as his reason that he wanted to get away, as he had learned all there was about the work, except the details. He got his time.

But the vast majority of Canadian boys are manly and self-reliant. My only regret is that more of them do not stay with us. Like all other commercial enterprises I know of, we are always hard pushed, to find among our men some men of intelligence and experience to make foremen. I can assure you that such men are hard to find. Many times we have had to put in responsible positions men who were none too well qualified for these positions, simply because no other was available. What we and many other firms need is bright young men who will remain in our employment, even if their present positions are not exactly to their liking, until we have had time to move them from one department to another in order that they may get a broad experience in this work. But very frequently the very man we have talked over and planned to move into some more responsible position, gets another opportunity offered him elsewhere, and when we want him, he is gone. This fact which I wish to emphasize, shows very clearly that the demand for such intelligent work as these boys give is greater than the supply. This fact disposes in very large measure of Mr. Crane's argument that the technical schools turn out a lot of young men who are worthless to their employers, and who can not obtain responsible positions. But Mr. Crane goes on: These technical school men are not fully trained craftsmen, they are not competent along any one line. They come out of college and have to compete with the uneducated laborer, who, by sheer dint of sticking to one line of work, has mastered that line, and is receiving good wages. This is very true. Take a college boy who has studied, say electrical engineering, goes into the shops at Peterboro'. He finds there men who can do the work he is put at far better than he can, men who know nothing but this particular work.

*Address delivered at dinner of School of Mines, Queen's University, Dec. 12th, 1911.

†Superintendent Lake Superior Corporation.

These are his competitors. He has to accept their wage rate, and pit his brains against their experience. He is at a disadvantage for a time. If he considers his present condition only, he may regret that he had not followed Crane's advice, which, you will remember, was to omit the technical school course, go directly into a shop, and spend four years of practical training at one line of work.

Now, all I say to this is that if a boy desires to become a highly efficient machine, this is certainly the best way to go about it. The modern shop is always in advance of the technical school, the surrounding influences are all in one direction, and a young man thus spending six years of his life is undoubtedly a better craftsman, and can immediately earn higher wages than one who has spent four or six years in a university.

We will admit once for all that there are some subjects which a university or technical school cannot teach, does not attempt to teach, and should not be expected to teach. A university does not aim to make machines, but to make men. It does not take a boy and perfect him along one narrow line. It aims to lay broad foundations, to inculcate principles, to train in culture, to foster a taste for all that makes life liveable and men and women lovable.

Take this technical school here for example. If a boy wishes to become a mine foreman, or a smelter man, or an expert winder of commutators, he will never get that training here. Any of your professors would advise to go into the mines at Granby, or the smelter at Copper Cliff, or into the General Electric Works at Peterboro'. In four or five years he would be a skilled craftsman, he would earn three or four dollars a day, he might even be in charge of some commercial enterprise—but that is all. He would be successful as he measures success—but what a price to pay for such a limited success. Like Selkirk on Juan Fernandez, he is monarch of all he surveys, but how far can he survey; how limited his horizon?

Many, many generations have gone by since the preacher said: "Where there is no vision the people perish." Where there is no vision, no broad outlook on life, no scope for larger ambitions. What phrase could better describe the condition of one who spends his best years in mere striving to learn a craft whereby to earn his daily bread.

This is all the training, such as Mr. Crane proposes, can give, the certainty of daily employment. Is this, then, all we are to strive for? Is the training we get here simply a meal ticket?

I claim that life is more than this. Man cannot live by bread alone. Remember that happiness arises not merely from greater earning power, but from greater capacity for enjoyment.

There are schools, exactly such as Mr. Crane describes, where a man can learn to be a telegraph operator, or a stenographer, a watch-maker, or a barber, and at the end of his training course he comes out a brisk, useful craftsman, needing only practice to make him perfect.

But what profiteth it a man if he gain the whole world and lose his capacity for enjoyment? Wherein is he a gainer if he can earn a living, and his life is not worth living? He can wind a commutator, but he has never heard of Franklin or Faraday. He can cut stone or mix paints, but is blind to the smile of the Venus of Milo or the grace of the Sistine Madonna. He can tune a piano, but is deaf to the pathos of Beethoven and the pious exaltation of Handel. He can survey a wilderness into town lots, but has never lifted his thoughts to the Pleiades and the flashing belt of Orion. He has mastered the books of the Scranton Correspondence School, and has never heard of the madness of Hamlet, or the troubles of Tristram Shandy. He can work for a party victory in his own riding, and knows not that his liberty to vote was won by Pyne and Hampden and William the Silent and Stephen Langton. He is living by bread alone. He has no vision, he cannot see the world as a whole, he has bartered his birthright for a mess of pottage, and sold his manhood for a meal ticket.

You are taught here many things which may appear to you dry, tedious, irrelevant, uninteresting. Never mind that. You will forget more than you will remember. But always remember this: it isn't the water that stays in the fleece that scours it, it's the water that goes through the fleece. It isn't always what you remember that does you most good, it is the act of grasping new ideas, of fixing the attention, of facing novel problems, of training your brain to act quickly in emergencies. These studies you grind out here are useful, not solely for what you remember of them, but for what they suggest to you.

Mathematics is not, as the Beloved Vagabond says, a lot of damned facts about triangles, it is the plan on which the Creator fashioned the universe.

Chemistry and biology are not the mere study of reactions and adaptations, they are the keys to all life, past and present. Mining and metallurgy are not hand-crafts, they are the factors that open new continents and change the map of the world. French and English are not simply languages in which to call for another wheel-barrow of concrete, they are the open doors to the literature and history, the wisdom and pathos, the wit and humor of a thousand years.

All this broad outlook on life is summed up in one word —culture. No one can give you this, but every college gives you an excellent opportunity to attain it. Culture, friendship, inspiration—these are the three things that make life worth living, three things which are here for you to grasp and take with you.

Culture, as I have said, comes from the study of broad principles, and can never be attained by undivided attention to one narrow subject. Here in these halls, among these libraries and museums, you have the chance to attain it.

Friendship, the good-will and affection of your fellows is here also for you. You cannot dig this out of dead books. Here around you are young men who may be leaders of the future. Learn to know them, find out the best that is in them, be loyal to them, for as the Norse proverb says: "Back is bare without brother behind it." The loyalty you give to the captain on the campus is the same loyalty that has made Canada a great country, and some day will make it, in name as well as in fact, a great self-governed, self-centered nation.

Inspiration meant the inbreathing of a great spirit, the breath of life in man's nostrils. We cannot define it, we cannot analyze it, we can only feel it, as we feel a chord in music. It comes from the consciousness of the presence of the mighty dead who have moulded the nation, it comes from the companionship of noble men and women living around us, from the memories with which the college halls are hallowed. You know the feeling that comes over you in a close-packed crowd when the leader rises and you see the tense upturned faces around you and hear the quick intake of breath, as the truth he speaks sinks home. You picture the gaunt figure of Lincoln at the National cemetery and the hushed audience that hangs on his words as he gives them the greatest speech ever made in the English language, the matchless Gettysburg address. They turn away, too deeply moved to applaud, too much uplifted to cheer, because they have received the inspiration, they have seen the vision.

There has been in every college some man around whom the highest and noblest ideas have crystallized, men who have moulded the nation, such men are our greatest inspirations. Such men as Arnold of Rugby, Elliot of Harvard,

Wilson of Princeton, Angell of Michigan, are fit companions of the greatest Grant of Queen's. These are the men who have made us men. Can any narrow course of training such as Mr. Crane desires, give us anything for which we would exchange these memories? Never. Man cannot live by bread alone.

You will go from here in a few years less skilled perhaps in the profession you enter than many a trained apprentice, you may earn less for a few years than if you had never come here, you will have your struggles as we have all had, but if you have learned how to be thorough and manly and self-reliant, to be honest and kindly and clean, in a word, if you are true to the tradition of Queen's you cannot fail of success; but when you do attain your ideals you will have brought with you a greater capacity for enjoyment, a broader outlook on life, a nobler patriotism, and a higher ideal than if you had never spent these years at Queen's, for you will take with you somewhat of these three, culture, friendship, inspiration, to broaden and brighten your life, and you will have glimpsed the vision without which the people perish.

CONCRETE SIDEWALKS.

By S. B. Code, O.L.S.

Owing to the superior qualities of cement concrete, as well as to its low cost in comparison with that of other materials formerly used, concrete sidewalks are now almost universally used in every city, town and village. All the requirements necessary in a walk are met with by this material, the chief of which are (1) an even surface, (2) solidity, (3) durability.

Specifications for sidewalk construction are not new, and it is not the intention of the writer in this short paper to give a list of specifications, but rather to deal with the question of what is the best mehod of carrying them into effect.

Some municipalities adopt a system of building their walks by day labor, others the system by contract. In the former case a foreman being employed, in the latter case an inspector looking after the work. The responsibility of the whole work devolves upon either of these men. When the work is done by contract and an inspector is appointed, it has been the experience of the writer that municipal councils are not careful enough about the selection of the inspector. Either they look to the side of cheapness and give the position to the lowest bidder, or else through sympathy or influence on the part of the members engage an incapable. The inspector should be a man of integrity, ability, and beyond suspicion, also possessing some energy, and not one who on a hot afternoon will sit down on a doorstep and go asleep while the contractor is at the same time "making hay while the sun shines."

The possibilities of cement-concrete are probably not fully appreciated, while it is also a fact that defects are to be found in concrete construction, and especially in walks, but these defects may in most cases be traced to lack of knowledge of the materials used in construction, to inexperience in such construction, and to neglect and failure on the part of the builder or inspector, to appreciate the importance of the minor details. Cracks in walks are not always caused by an improperly prepared foundation. A fractional part of a block should not be left over even for suspension of work at the noon hour. This often occurs, and when work is resumed fresh concrete is placed against that laid in the forenoon and a top coat placed over all. The concrete in the separate parts will not properly bond, and the result is invariably a crack in the walk at this place.

To obtain best results only first-class materials should be used. The labor is the largest item but could be saved for laying the walk with poor materials as with good materials. First-class materials, skilled labor, complete specifications, a capable and efficient inspector who will see that the specifications are enforced, should give good results. Very often the inspector is too lax, and carelessness of one kind is encouraged by another. The selection of materials is the first consideration and is an important matter. Portland cement of high grade should be used, the same subjected to a close test, as it is well to take nothing for granted. As more reliance can be placed upon a reputable brand of cement than upon a natural deposit of sand, gravel or stone, it is thus important that the quality of the aggregate should receive careful attention. The surfaces presented by the particles composing the aggregate should be hard and permanent. A covering of any fine superfluous material will interfere with the cement or mortar getting into contact with the surface of the aggregate and thereby reduce the strength proportionately. The aggregates should be well graded and should not contain an excess of one size particles and a small amount of fine particles. The crushed stone should be hard and durable, clean and free from a covering of dust or other matter. In sand and gravel one is dealing with entirely different materials, and materials that should be selected with great care. Shaly particles are undesirable because they are both weak and unstable, and a concrete can never be stronger than the material making up the aggregate. The size of the sand grains and the relative proportion of grains of different size have a very marked effect upon the value of the sand. At least 75 per cent. of a sand should be retained on a 40-mesh sieve with the particles well distributed between that size and the size passing a 4-mesh sieve, with an increasing proportion on the coarser sieves. Such a sand will have much less total surface than one sand made up entirely of fine particles will present a very much larger surface which must be covered with cement than either of the sands above mentioned. The total superficial surface of a given volume of spheres one-eighth of an inch in diameter is four times the surface of the same volume of spheres one-half an inch in diameter. To obtain first-class concrete it is necessary to perfectly cover every particle of sand with cement, and every particle of the coarser aggregate with the cement sand mortar. It is therefore essential that materials with an excess of fine particles should not be used. Compressive strength is in favor of the coarser material. To give the maximum strength and use at the same time the least cement, the aggregates should be so graded as to have each successive size material fill the interstices left by the preceding larger size. It has been found by experiment that aggregates exceeding one and one-fourth inches in diameter should not be used. The lower limit, one quarter of an inch, which is also the upper limit for sand and stone screenings, is almost universally accepted.

The foundation should provide a permanent bed for the walk, and serve as a means for disposing of water which would otherwise accumulate under the walk. It is very important that the foundation should be so constructed that neither time nor the elements can change its ability to support the walk. It is usually necessary to prepare the subgrade, upon which the foundation is established. If the soil at the excavated grade is firm and solid there is no necessity for further preparation, but if it contains any soft, boggy or spongy places, these should be removed and the holes filled with firm material and thoroughly consolidated by ramming or rolling as the filling progresses. The preparation of a fill for the sub-grade requires care. The upper portion of the fill should be tamped in layers not to exceed six inches

in thickness. The sides of the fill should be given a slope of not less than 1½ to 1, so that it will not slip away, and when granular materials are used the sides should be banked on the slope with sod or clay.

Any piece of work is large enough to justify a study of the aggregates for the purpose of determining the correct proportions. It has been stated that the ordinary mixture for water-tight concrete is about 1 part cement, 2½ parts sand and 4½ parts coarser aggregate, which requires 1.37 barrels cement per cubic yard of concrete. The most practical way of arriving at the proper proportions is by the determination of voids, or space that is occupied by air. In order to eliminate the error which might arise from absorption of water in the process of determination of voids, the material, if dry, of porous, should be wetted slightly and afterwards dried so as to remove this moisture from the surface. In the actual process of determining the voids, a cylindrical vessel of metal of 1 cubic foot capacity may be used. The vessel is first weighed and then filled level full of water and weighed again. Call the net weight of the water C. Empty and dry the vessel and fill level full with the aggregate. Call the net weight of the aggregate B. Pour water slowly into the aggregate until the vessel is again level full of water. Call the net weight of the aggregate and water A. The formula then is per cent. voids equals $\frac{A-B}{C}$ 100. To determine voids in sand and stone screenings, the sand should be poured into a vessel containing water. The object in doing this is to eliminate the air, which is impossible if the order is reversed. When the vessel is level full of sand and water, the weight is determined and the formula given for the coarser aggregate applied.

Proper mixing of the materials composing the concrete is very important. Machine mixing has its advantages and its disadvantages. The sand and cement should be first mixed dry and then mixed wet into a homogeneous mortar. The coarse aggregate previously mixed should be added to this mortar, and all thoroughly mixed together. Hand mixing, if carefully done, is entirely satisfactory. Oftentimes mixing is sadly neglected, or is entrusted to unskilled laborers who have little or no appreciation of what is really necessary and less interests in final results. Machine mixing with the batch type of mixer is reliable.

About every fifty feet a good expansion joint should be made. This may be accomplished by replacing one of the wooden cross forms by a metal parting strip, which should be left in the walk until it is open to traffic, when it will be removed and the opening thus produced filled with pitch or other suitable material.

Care should be exercised in adding water to a concrete mixture, because, as is often the case, the water is thrown on a bucket full at a time, and the cement is thereby washed from the mixture. The water should never be added faster than it can be taken up by the materials. When additional water is required in a mixture it is a good practice to add it in a spray.

Concrete or mortar which shows preceptible hardening or drying out should not be re-mixed nor used. Any disturbance of concrete after hardening has begun will weaken it.

Where hand-mixing is made use of the concrete is usually mixed on a water-tight platform, and the size of the batch may be governed by the speed of mixing and depositing in place. Before placing the sub-base should be previously wet and tamped and the concrete deposited immediately after being made, having regard for the preservation of the proper proportions. As the concrete is usually deposited with wheelbarrows, there is a tendency for the cement, being fine, to be carried in suspension with the surplus water away from the other materials. On hot drying days the loss of water by evaporation from the mixture should be prevented, as it forms an essential constituent part of the concrete.

The top finish, when put on separate from the concrete, should be a mixture of one part of cement to one and a half parts of screenings or coarse, clean sand. This should be put on immediately after the concrete has been consolidated. Any time which elapses between the laying of the concrete course and the laying of the finishing course, will seriously interfere with the bonding of the two. The longer the interval the more drying out will take place in the concrete, and there is no assurance that a perfect bond can be attained, except by special treatment, such as cleaning off any dust, sand or foreign matter and applying a wash of neat cement and water.

A very important point in sidewalk construction, and one which is very much neglected, is the making of proper expansion joints. Usually the place for the joint is marked on the edge of each form and an attempt is made at making a sort of indifferent joint by forcing a thin piece of iron or a trowel through the base. This is filled with dry sand. Afterwards the top finish is floated and trowelled and before setting the same tool is driven through the finish in an endeavor to strike the opening in the base. Often, through carelessness, this top mark is not made directly over the bottom mark, but the two marks are some distance apart and the result is invariably a break in the top above the joint in the base. A good joint can easily be made, as stated in the foregoing part of this paper.

After the walk has been completed care should be exercised to protect it from the action of the elements. A covering of canvas or other material is usually used, as too rapid drying in a hot sun is apt to result in checking. After the cement has thoroughly set it is a good idea to keep the walk moist for a time.

STATISTICS OF WATER POWER DEVELOPMENT.

A brief prepared by the public policy committee of the American Institute of Electrical Engineers and presented at the public hearing before the United States National Waterways Commission, Washington, November 21, contains among other statistics the following interesting data:—

"The statistics of water power collected under the direction of Congress several years ago and embodied in the report of the National Conservation Commission of 1909 show that there is at present developed in the United States about 5,000,000 horse-power of water power.

"The amount of power produced by steam from coal is difficult to estimate, but is considered to be about 27,000,000 horse-power, and is rapidly increasing, with attendant depletion of coal reserves. A large part of this it is not only possible but easy for water power to replace if it were made freely available through development. Within range of development at a cost of investment that would make the cost of such power about equal to that of steam power, there is still undeveloped in the streams of the United States about 35,000,000 horse-power.

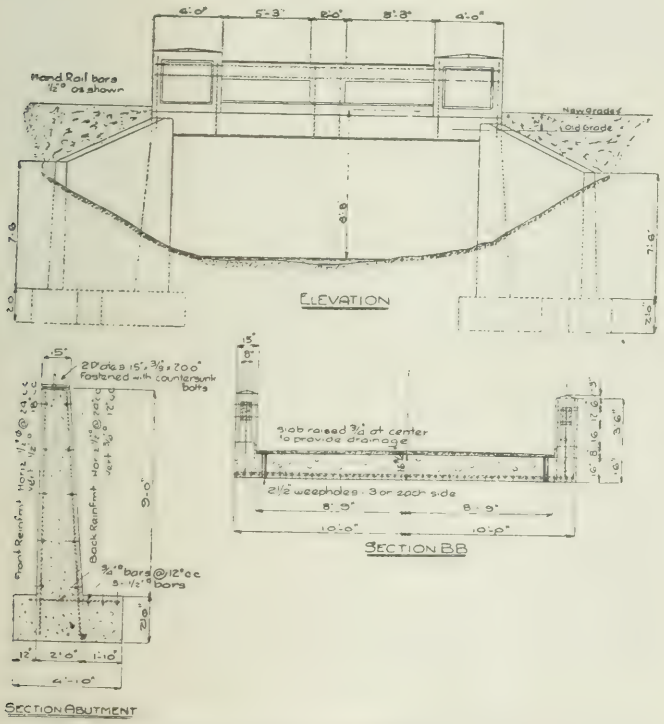
"Any acion by Congress that would accelerate the release of this power would conserve enormous supplies of coal for such domestic and industrial purposes as only coal can supply."

THE CONSTRUCTION OF A MODEL BRIDGE IN IOWA.

The construction of a model bridge is described by Mr. C. B. McCullough, assistant engineer of the Iowa State Highway Commission, in a recent issue of Good Roads. The following is abstracted from the description as being of interest:—

During the past few years, the State Highway Commission of Iowa has devoted considerable attention to the construction of model reinforced concrete culverts and short span bridges throughout the various counties of the State. While the cost of any one of these structures, considered as a unit, is rarely as low as could be desired, their value to the counties from an educational standpoint, and to the concrete industry, is sufficient to warrant a much greater expenditure if necessary.

The construction work has just been completed on a bridge of this kind crossing Wolf creek, in Clay township, Grundy county. The bridge is a reinforced concrete slab of 18 ft. clear span, and a clear roadway of 17 ft. 6 ins. The construction work was done by the county bridge crew under the general direction of the writer, who attempted to keep an itemized and accurate account of the cost of each operation. Because of the fact that very little data of this kind on structures so small as this, has been published, and because the design of the bridge embodies several features such as the use of shop built reinforcement, which should interest every county bridge official, a brief description of the design and an account of the construction is here submitted.



Elevation, Slab and Abutment Sections, Bridge No. 1301, Wolf Creek.

Abutments.—The abutments were designed as simple retaining walls to withstand a horizontal pressure equal to one-third the vertical, including a surcharge of 2 ft. above the bridge seat. The reinforcing in the back and top of footing was made of sufficiently great cross sectional area to withstand the tendency to crack at base of stem, while the bars in the front face were simply a precaution against frost and other action, which would threaten to crack the abutment horizontally in front, should the expansion joint at the bridge seat become defective. While this latter precaution is perhaps not absolutely necessary, it seemed warranted by the number of abutments throughout the state which have developed horizontal cracks for seemingly no other reason. An analysis of the abutment, account being taken of the dead weight of that portion of the slab resting upon it, shows the resultant line of pressure to pierce the base a little outside of the middle third, resulting in a maximum toe pressure of about 4,200 lbs. per sq. ft., and a factor of safety against sliding along the base of about two. In the design, no account was taken of the increased stability due to the action of the wings, although these were positively connected to the body of the abutment by means of the hooking of the reinforcing bars.

Slab.—The slab was designed for its own dead weight plus 6 ins. of earth fill, together with a live load consisting of a 12-ton traction engine, two-thirds of the weight of which was considered concentrated on two rear wheels, 5 ft., centre to centre, and 11 ft. from the front trucks, on which the remaining one-third of the weight is concentrated. The weight on each of these wheels was considered as being distributed transversely over 4 ft.

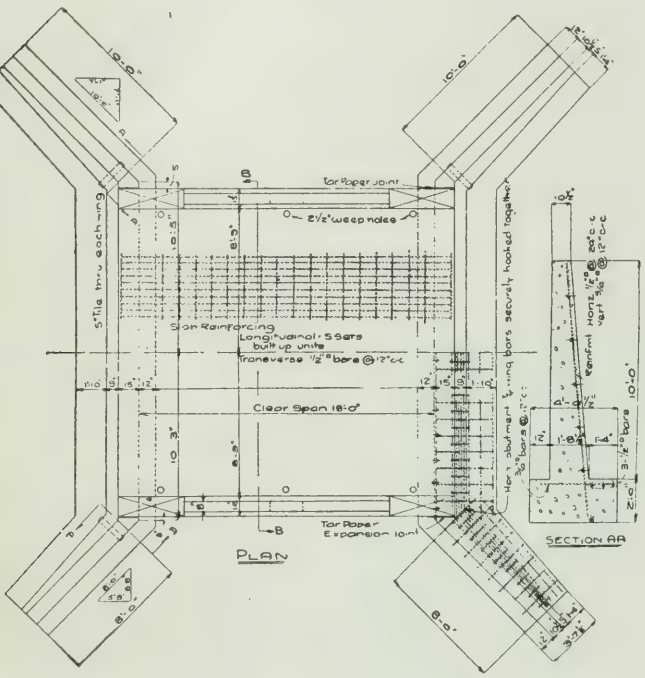
The longitudinal reinforcing for the slab comprised 5 units of shop built reinforcement. These units were fabricated in the shops of the A. E. Shorthill Company, of Marshalltown, Ia., and consisted of ten ¾-in. square, plain, mild steel bars, part of which were bent up at an angle of 30 degrees, at the points shown in the drawing, for diagonal tension. Both the bent and the straight bars were passed through a ⅜-in. rectangular plate at the end, making therewith a positive connection by means of hooking and cold riveting. These units were 4 ft. in width and weighed about 565 lbs. each. They were built and shipped ready to place.

The use of shop built reinforcing eliminates the uncertainty as to whether the bars in the structure really occupy their computed positions, and also rendered the placing of the slab steel comparatively easy, while the use of the plate at the end secured the bars against any slipping due to lack of bond strength at the ends and consequent diagonal tension or shearing failure. The transverse reinforcing was of high carbon twisted square rods, as was practically all of the other reinforcing steel. Provision for drainage of the slab was made by the insertion of six 2½-in. gas pipes through the slab at points indicated on the drawing.

Expansion Joints.—Provision for expansion was made on both ends of the slab by means of two steel plates, 15 ins. by 20 ft. by ⅜-in., placed on top of each abutment with countersunk bolts, bonding them to the concrete. The wings were separated from the slab by means of an ordinary tar paper joint, as shown in the drawing.

The form lumber used was practically all new. Number 1 ship lap, 1 in. by 8 ins., being used for the casing and lagging, while 2 by 12's and 2 by 6's were largely used in the hand rail form work. The studding was of 2 by 4's, spaced 16 ins. centre to centre, and two-ply caps of 6-in. by 8-in. material placed over an existing bent of piling constituted the centreing over which joists of 3-in. by 12-in. county bridge plank, spaced about 14 ins. in the clear, were placed. The lumber was in fairly good condition upon removal, and with reasonable care should be good for the construction of four more bridges. A depreciation of 33⅓ per cent. of the first cost was figured as the cost of the lumber. The tables of cost data give the actual cost of the bridge, no allowance being made for contractor's profit, superintendence, engineering or overhead charges, such as depreciation of mixing plant, etc.

Inspection of the cost data will show that the material ems make up by far the larger portion of the cost of the ructure, about 77 per cent., in fact, while further examina- on will show the hauling charge as being about 35 per ent. of the total material charge. In other words, the ame structure could be erected at the site of the material or $850.39. The hauling was all done by teams over an xceptionally long haul, and the large amount to which this auling expense runs seems to emphasize the desirability f utilizing some form of tractor for hauling of this kind in aces which are situated very far from a railway station.



lan and Wing Section, Bridge No. 1301 ("King" Bridge), Grundy County, Iowa.

Due to the fact that the footings were carried down omewhat deeper than shown on plans, and to other slight hanges, the total yardage was somewhat greater, being bout 92.5 cu. yds. Based on this figure, the total cost er cubic yard was about $12.60, which was exceptionally gh because of the unfavorable conditions.

Some unit costs, based on the actual quantities used, re as follows:—

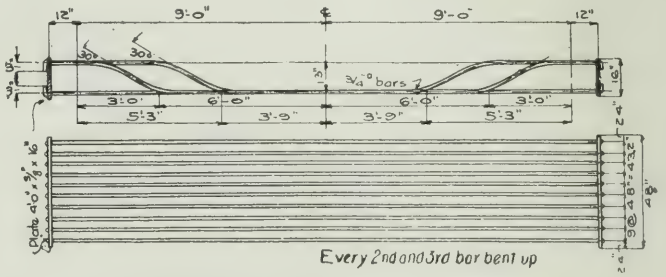
lacing form lumber, per 1,000 B.M.	$7.660
emoving form lumber, per 1,000 B.M.	2.220
lacing concrete, per cu. yd.	.650
lacing steel, per cwt.	.095
'et excavation, per cu. yd.	.850
ry excavation, per cu. yd.	.370
abor on hand rail, per lin. ft.	.620
lacing foundation cribbing, per lin. ft. (perimeter of opening)	.060

Table Showing Labor Costs.

Account	Hours	Rate	Amount
emoving old bridge	6	25c.	$ 1.50
emporary bridge	43	25c.	10.75
ry excavation	22	40c.	8.80
hannel change	10	25c.	2.50
ry excavation	37	25c.	9.25
'et excavation	14	40c.	5.60
'et excavation	154	25c.	38.50
uilding foundation cribbing	33	25c.	8.25
Building forms (not including hand rail)	182	25c.	45.50
Placing and wiring steel (not including slab)	14	25c.	c. 3.50
Mixing and placing concrete (not including hand rail)	231	25c.	57.75
Runaways and platforms	16	25c.	4.00
Placing slab reinforcing	16	25c.	4.00
Painting forms	5	25c.	1.25
Hand rail, building forms	57	25c.	14.25
Hand rail, placing concrete	45	25c.	11.25
Removing forms	56	25c.	14.00
Removing forms	6	50c.	3.00
Miscellaneous (trips to town for equipment)	26	40c.	10.40
Moving plant	30	25c.	7.50
Moving plant	10	40c.	4.00
Total			$265.55

Table Showing Cost for Material.

Item	Amount	Rate	Cost
Lumber (casing and lagging)	3,200 ft. B.M.	$10.00	$32.00
Lumber studding and centreing	4,500 ft. B.M.	10.00	45.00
Cement	163 bbls.	1.68	273.84
Gravel	105 cu. yd.	.50	52.50
Steel	78.7 cwt.	2.16	170.00
Miscellaneous:			
Drain pipes			.50
Form oil			6.00
Hardware, nails, etc			5.00
Cost of material only			$584.84



Detail of Shop Built Slab Reinforcement.

Hauling Material.

Item	Hours	Rate	
Lumber	35	45c.	$15.75
Cement	110	45c.	49.50
Gravel	525	45c.	236.25
Steel	25	45c.	11.25
Total cost of hauling material			$312.00
Total cost for material			897.00

CABLE CONVEYERS.

The Jeffrey Manufacturing Company, Canadian Works, Montreal, Quebec, have recently received orders for four cable conveyers for the Lake Superior Pulp & Paper Co., at Sault Ste. Marie, Ontario. Geo. F. Hardy, mill architect and consulting engineer, is furnishing the designs and specifications.

DIFFICULTIES OF RECORDING CONSTRUCTION COSTS BY USUAL METHODS.*

The statement has been made that the ordinary methods of cost determinations are almost valueless. This applies both to cost keeping as carried out by the builder and to the force account of the supervising engineer. The fundamental reason is that guess work methods have been used in place of accurate scientific methods.

To obtain cost records that are of value to the builder or to the engineer, several essential elements must be recognized, even if methods of unit times are not used. These essentials may be outlined as follows:

(1) Accurate subdivision of the work into distinct operations.
(2) Accurate records of time.
(3) Knowledge of exact quantities.
(4) Proper apportionment of cost of plant.
(5) Proper apportionment of general expense.
(6) Proper apportionment of cost of materials.
(7) Full description of each item of work.

(1) Accurate subdivision of each section of the work into its distinctive operations is of prime importance. The methods described afford the means of dividing the work into its proper elements with great accuracy. The same general scheme of division, however, carried to a lesser degree may be followed in ordinary cost keeping with far better results than have usually been attained.

In the construction of a concrete conduit, for example, the cost records at least should separate the labor into such operations as: Lay invert, place and remove centers, lay the arch, place the reinforcing metal (if any is used), and finish the interior. If fewer divisions than these are made, the total costs obtained may sometimes show the cost to the contractor of this particular job as a whole and may also indicate the probable cost of another conduit of exactly the same design, but these are the limits of their value.

(2) That accurate records are necessary would seem self-evident, but the difficulty in making an exact count of the men at work on the job, and an exact memorandum of the times, is surprising. Generally the men are constantly changing position, and frequently one or more of the men in the gang may have been taken away to fetch material or for some other purpose, so that they are left out in the count. A timekeeper learns to guard against these difficulties to a certain extent, although frequent mistakes are made unless the man is constantly on the spot. The time on force accounts, or even on a contractor's cost keeping records, is often taken by days or half days instead of by hours or quarter hours, and the workman's time is charged to the job he is on when the timekeeper makes his round, so that the returns are inaccurate. In other cases a whole day's work is credited to a certain item even when the men leave before quitting time or change on to other work.

(3) Knowledge of the exact quantity of work performed is as necessary as the recording of the times for doing the work. In certain classes of work differences in the condition of the material affect the quantity. For example, in earth work, or in the handling of sand and gravel, not only is it difficult to measure the quantities, but there is a large percentage of difference in quantity depending upon whether the material is measured in the cut or loose or shaken.

(4) The cost of the plant, including its first cost, depreciation, repairs, and renewals, is an extremely important item and requires careful judgment in apportioning. The factors which must be taken into account in a concrete mixing plant, for example, are the probable value of the plant after the work is complete, the number of days per year in which it can be operated, the time lost in shut-downs for repairs, and the actual cost of repairs and renewals. The cost of tools, such as shovels, picks, etc., must be included in the cost of plant unless otherwise provided for.

(5) On a small job the general expense is readily apportioned. Upon a large job where the work includes, for example, earth excavation, rock excavation, concrete, and riprap (and often several different classes of each) not only the pay for the foreman, but the salaries of the general superintendent, the contractor's engineer, the timekeeper, and the office force (a part of which is sometimes located on the work and a part at the contractor's general offices) must be fully known, and properly apportioned to each class of work. The method that sometimes has been followed of dividing the total general expense by the number of classes of work into which the job is divided is inaccurate, because one class may cost ten times as much as another. The division of cost is difficult because the cost is not known until after the records are taken. A simple method, which is sufficiently accurate in most cases, is to approximately divide the general expense in proportion to the number of men engaged on each class of work. The division need not be made mathematically, but by estimation. The accountant may judge, for example, from inspection of the records that three-tenths of the general expense should go to one class of work, one tenth to another class of work, and so on.

(6) The cost of materials must be divided among the work actually performed. Materials sufficient to last for several months may be purchased during a single week. If this total cost is divided by the number of yards of concrete laid, for instance, in a week or a month, the result will be very misleading. On one job, for example, the unit cost of a certain class of work, as given in the engineer's cost sheets, varied from 73c. in one month to 19c. in another, solely for the reason that most of the materials were purchased the first month and were all charged up to the cost of the work during that month. To provide for this, the accountant should know the approximate amount of material used in a definite quantity of work, and should carry forward the material on hand. If this division is impracticable, the next best way is to keep the material and labor separate, and allow the man who is making up the cost sheets to estimate the cost of the material from his knowledge of quantities.

(7) Lack of description renders many careful records of cost absolutely valueless, except for determining whether a contractor is making money. For example, on one job very accurate records of cost of earthwork were made by the engineers, giving the number of men employed, the number of carts, cost of superintendence, cost of tools, and many other details, while the length of haul or the character of the material handled was not stated. The result was an accurate record of the cost of labor on this particular job, but one which was absolutely useless in estimating the probable cost of other work, of a similar nature, that was being done by the same engineering commission. In another case, the times of the men on all classes of work, including the engineer and other men in the various offices of the contractor, were carefully recorded on large cost sheets. The work included several kinds of concrete construction. One kind was found to cost $4.08 per cubic yard, another kind $6.28, and another kind $7.98, but nothing was shown on these sheets to indicate the reason for these differences. No definite description was given of the character of either job, and the only means of comparing them would have been to look up the contract and the plan, and then probably find that each class covered so broad a range as to provide no

*From "Concrete Costs," by Frederick W. Taylor and Sanford E. Thompson. Copyright, 1912, by Frederick W. Taylor.

definite information. The amount of information required to properly describe any piece of work depends upon its character and the minuteness of the cost or time observation. If simply general costs are being compiled, the analysis of almost any class of work will show that there are a few, perhaps not over a half dozen, essentials which will usually give reason for an apparently low or for an excessive cost. Although, even with such data, cost keeping will not give the exact basis for estimates that may be obtained with the more scientific methods of unit times, the results may be recorded in such a way as to aid materially the judgment of an experienced engineer or a contractor.

STRENGTH AND FATIGUE PROPERTIES OF WELDED JOINTS.

At the meeting of the Institution of Civil Engineers on Tuesday, December 12, Mr. T. E. Stanton, D.Sc., M.Inst. C.E., and Mr. J. R. Pannell, presented an account of some experiments on the strength and fatigue properties of welded joints in iron and steel, which were undertaken at the suggestion of Sir John Wolfe Barry in 1908, the object being to obtain a comparison of certain properties of welded joints —made by different processes and by different makers— with the corresponding properties of the unwelded material from which the joints were made. It was hoped that by this means some estimate of the general reliability and efficiency of modern welding processes might be arrived at. In order to obtain material for the work a circular letter was sent from the National Physical Laboratory to various engineers inviting them to submit specimens of welded joints for testing. Sixteen firms responded to this invitation and the total number of welded joints received was 167. The method of welding and treatment of the joints was left entirely to the makers, the only condition being that all specimens should be made from bars 1¼-in. in diameter. The tests to which the joints were subjected were: First, a tensile test; and secondly, a fatigue test by the Wöhler method. The former included determinations of the elastic limit, the yield point, the maximum stress, the total elongation, and the general and local elongations.

For the rapid carrying out of the fatigue tests a machine was constructed in which the specimen was rotated at a speed of 2,200 r.p.m. Owing to the results of a previous investigation with another type of machine having shown a decided reduction of fatigue strength with increased rapidity of stress-alternation, preliminary experiments were carried out to determine the amount of this effect for the particular type of machine used. The results showed that for speeds of 200 and 2,200 reversals per minute there was practically no difference in the fatigue strength. The assumption was therefore made that the apparent reduction of fatigue strength with rapidity of alternation in the case referred to was a characteristic of the machine used.

The mean results of the tensile tests on the welded joints, expressed as a percentage of the strength of the original material from which the joints were made, were:—

	Per cent.
Hand-welded iron	89.3
Hand-welded steel	81.6
Electrically-welded iron	89.2
Electrically-welded steel	93.4

Joints made by the oxy-acetylene process were also submitted by two makers, but the results were not comparable with those obtained by the hand or electric processes.

The various determinations made in the tensile tests showed a distinct want of uniformity in the material in the region of a weld, but the results of the fatigue tests proved that this does not materially effect its resistance to reversals of stress. When failure under alternating stresses of low value takes place, it is invariably due to a defect in the actual weld itself. The number of defective joints which were discovered in the whole investigation, however, leads to the broad conclusion that in important work, where the failure of any particular welded joint may involve serious damage to the structure, the subjection of each joint to a proof-load is still desirable.

WESTERN MILEAGE OF THE CANADIAN PACIFIC RAILWAY.

By H. M. P. Eckardt.

Canadian Pacific's recent announcement of a new stock issue of $18,000,000, which will bring $27,000,000 into the company's treasury, draws attention to the yearly additions to Canadian Pacific Railway mileage in western Canada. The immigration movement, which assumed its especial importance five or six years ago, is the principal factor in causing western prosperity. This immigration movement has, incidentally, been instrumental in inducing the railways to increase their western mileage. Then, in turn, the policy of active construction of new branch and main line of railroad, has induced more immigration and more prosperity. By means thus of action and reaction, western progress has been steady and rapid. It will be interesting to study the extent of the Canadian Pacific Railway's yearly construction work west of Lake Superior during the period 1905 to 1911.

Before detailing the additions made to the western portion of the system, it will be well to trace the development of the mileage of the whole system. In the following table the summary for the six years is given:

Year.	Mileage in C.P.R. Traffic Returns.	Mileage Other Lines Worked.	Mileage Under Construction.	Total.
1905	8,568.0	438.0	481.4	9,487.4
1906	8,776.9	438.0	923.7	10,138.6
1907	9,153.9	262.4	823.0	10,239.3
1908	9,426.4	261.7	708.4	10,396.5
1909	9,878.5	261.7	403.2	10,543.4
1910	10,270.6	261.7	471.4	11,003.7
1911	10,480.9	291.9	983.3	11,756.1

In the six years the total mileage of the company, exclusive of that pertaining to the Minneapolis, St. Paul and Sault Ste. Marie Railway, and the Duluth, South Shore and Atlantic Railway, increased 2,268.7 miles, or an average of 378.1 miles per year.

In connection with this increase of mileage it is interesting to review the increase of capitalization concurrently taking place.

(Thousands omitted).

Year.	Common Stock.	4% Pref. Stock.	4% Cons. Deb. Stock.	Mortgage. Bonds.	Total.
1905	$98,738	$37,853	$89,200	$55,238	$281,029
1906	105,995	42,719	101,519	41,738	291,971
1907	121,680	43,936	106,045	40,238	311,899
1908	141,534	48,803	115,657	39,621	345,615
1909	150,000	52,696	128,930	39,621	371,247
1910	173,530	55,616	136,711	39,621	405,478
1911	180,000	57,076	142,861	38,648	418,585

Incidentally this table shows one respect in which the Canadian Pacific Railway finances are exceedingly strong. The portion of the capitalization represented by mortgage bonds is relatively insignificant; and it grows smaller every year. In the Canadian Pacific Railway's case there is no danger of decreas-

ing prosperity resulting in the property passing into the hands of the holders of mortgage bonds. More than nine-tenths of the whole capitalization consists of stock in three classes.

Proceeding now to the matter of additions to the mileage in western Canada, we get the follofing table:

Year.	Central Div.	Western Div.	Pacific Div.	Total.
1905	3,129.2	1,270.7	951.7	5,351.6
1906	3,526.4	1,369.3	953.9	5,849.6
1907	*3,438.1	1,364.9	1,093.6	5,896.6
1908	2,938.5	1,983.4	1,077.9	5,999.8
1909	2,905.9	2,146.4	1,077.9	6,130.2
1910	2,934.2	2,509.1	1,070.4	6,513.7

*Decrease due to the disappearance from the table of mileage of Qu'Appelle, Long Lake and Saskatchewan Railway, 253.6 miles, formerly worked by the Canadian Pacific Railway for account of owners.

In the annual report for June 30th, 1911, the mileage is grouped under the new style—according to provinces. It appears as follows: Manitoba Division, 2,353.7 miles; Saskatchewan Division, 1,878.8 miles; Alberta Division, 1,677.9 miles; British Columbia Division, 1,170.4 miles: Total, four western divisions, 7,080.8 miles. Thus the additions to the western portion of the system in the six years amount to 1,729.2 miles. The extensions in the West, constitute more than 76 per cent. of the extensions effected for the whole system.

It should be remembered that the Canadian Pacific Railway expends a portion of its newly raised capital and its accumulated earnings in other things than construction and purchase of new mileage. The steady additions to the steamship fleet absorb a considerable amount of funds; the extensions and improvement of stations and terminal property—notably the enlargement of the Windsor Street Station in Montreal—have required much funds. The building of new hotels, and the extensive irrigation works in the neighborhood of Calgary, should also be mentioned, and the constant increase in number and capacity of the locomotives, cars, and other equipment.

The balance sheet as at June 30th, 1911, showed the company's treasury to be in good condition. There was cash on hand, $34,371,550; temporary investments in government securities, $10,088,734, and current assets (consisting of agents' and conductors' balances, net traffic balances, and miscellaneous accounts receivable) amounting to $8,049,899. These items of the quick assets made up a total of $52,510,183. On the other side of the balance sheet were: Current liabilities (consisting of audited vouchers, pay rolls, and miscellaneous accounts payable), $17,203,651; coupons due 1st July and accrued fixed charges, $1,392,316. The surplus of available assets as at 30th June last therefore amounted to $33,914,216. This, however, represents a fall of about $16,000,000 as compared with the surplus of such assets shown on June 30th, 1910. That perhaps explains the new issue of common stock. The payments on the new stock are to pass gradually into the treasury. Judging from the record of extensions above given, western Canada will have the benefit of a considerable part of the expenditures based upon the increase of capital.

NEW BRUNSWICK.

The close of 1911 finds the people of St. John and of New Brunswick animated by a greater spirit of hopefulness and confidence than at any former period in the history of the province. There have never been at any one time before as many large projects under way, nor as bright an outlook for the development of the resources of the province. Premier Flemming stated recently that $20,000,000 would be spent in the province within the next five years. If we include the expenditure for harbor development at St. John, the Premier's estimate is too small. The St. John Valley Railway will cost $9,000,000. The harbor works at East St. John will cost nearly $5,000,000. There will be another $1,000,000 or more spent at West St. John. The railway from Fredericton to the Queen's County coal fields will cost $1,000,000. The Grand Trunk Pacific will expend considerable money, and there will also be the development of the oil shales of Albert County, the iron mines of Gloucester, and other enterprises of importance.

In view of the brighter outlook, the province will make a more determined and effective bid for immigrants than ever before. The St. John Board of Trade has agreed to subscribe $5,000 to establish a branch of the Imperial Home Re-union Association, which provides funds to enable immigrants already in the province to bring out their families. Branches will be formed in other centres, and the Provincial Immigration Department will co-operate in the work. In addition an agreement has been reached by representatives of the Provincial and Federal governments, under which the Federal government will undertake to induce immigrants to come in larger numbers to New Brunswick, and the Provincial government will undertake to look after them when they arrive.

A Washington concern is willing to erect at St. John a branch factory for the manufacture of paper bottles, provided some local capital is invested in the industry. The Board of Trade has taken up the matter, and it is believed satisfactory negotiations will be concluded.

The government of New Brunswick is negotiating with the Canadian Pacific Railway to have agricultural trains tour the province next spring and summer, giving demonstrations at various points on the modern science of farming, as is already done in the west and in the United States. Such matters as dairy and fruit farming, stock raising and seed selecting, will be given special attention.

While the contract for extensive developments at East St. John has not been signed, the government press publishes semi-official statements to the effect that the contract will be awarded to Norton Griffiths & Company, and that in the spring they will begin work on the breakwater, dredging, wharves, and dry-dock, which together will cost about $8,000,000. The work will cover a period of about five years.

While frozen halibut from British Columbia is being sold on the St. John market, very large quantities of frozen smelts are being shipped from New Brunswick to the American market.

The American lumber market has improved considerably, and orders are being received by local shippers.

The St. John City Council has adopted resolutions providing for a reduction of the assessment on improvements by 50 per cent., and an increase in the assessment on land, especially on vacant lots.

Sir William Mackenzie has purchased one hundred and ninety-two square miles of property in the oil shale areas of Albert County, and he intends to erect there a retorting and distilling plant, such as is used in the shale areas of Scotland. This great project, if carried out, will give employment to thousands of men, and with the natural gas and oil wells and the plaster quarries, will prove a source of enormous wealth in Albert County. The fact that the Canadian Northern Railway interests are investing in the province is in itself regarded as a very significant fact.

The exports by the winter steamships from St. John thus far this season are larger than those for the like period last year, and as usual a considerable portion of the exports are American goods brought to the Canadian port for shipment. The Canadian-Australian line will make five voyages from St. John this winter.

The Kent Northern Railway, which runs twenty-seven miles from Richibucto to Kent Junction, on the Intercolonial Railway, has been purchased by a Toronto syndicate. A local paper says the price was about $100,000. The line is one of the profitable short branches of the Intercolonial.—W. E. A.

Metallurgical Comment

T. R. LOUDON, B.A.Sc.

Correspondence and Discussion Invited

WROUGHT IRON, BUSHELLED IRON, INGOT IRON.

What is the significance of these terms? The first name is more or less familiar as a name to almost every one; the distinction between the first and second would puzzle many; the third term is becoming more and more familiar to engineers, but the meaning of is not yet generally understood.

Wrought iron is the result of a process in which a good grade of pig iron is worked in a puddling furnace as it is called (the operation of making wrought iron is known as puddling) the impurities, carbon, manganese, silicon, phosphorus, and to a certain variable extent sulphur, being oxidized out to form a slag. Owing to the fact that a high temperature is not attainable in the type of furnace used, the final metal, instead of lying in a molten state on the hearth, is found to exist as small soft globules distributed throughout the slag, the slag and intermixed iron being of a pasty consistency. Large balls of this mass are taken out of the furnace and, while still hot, are submitted to mechanical working, the idea being to squeeze as much slag out of the mass as possible; but in spite of all the squeezing and rolling there is always some slag left in the resultant bars of iron. If the metal be examined, however, it is seen that this slag is distributed evenly in fine lines (see Fig. 1.) and does not seriously interfere with the strength of the iron. The nature of the iron itself is worthy of note. It is extremely pure, the carbon percentage being low and as a consequence the iron is very malleable and ductile.

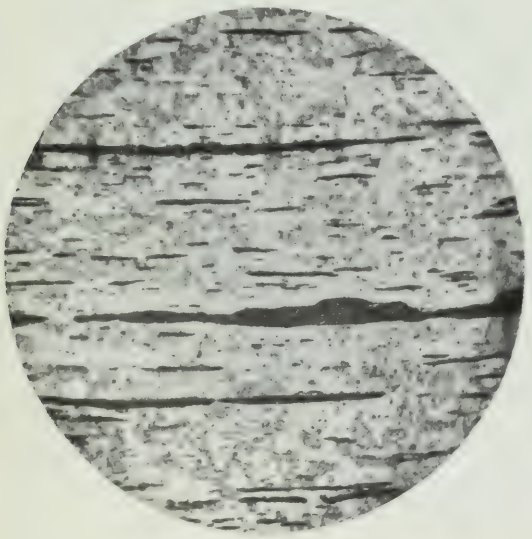


Fig 1.

The processes coming under the head of "bushelling," permitting as they do the utilization of scrap, might be referred to as economizers, but while they undoubtedly have a large and useful field to serve, this field should be thoroughly recognized and adhered to. In short, these processes consist of bushelling, i.e., making up bundles of suitable scrap, and subjecting a number of these piles to the heating action of a furnace somewhat similar in construction to a puddling furnace. When the scrap becomes more or less pasty, it is taken out and worked to a certain extent in the same manner as in making wrought iron. Ostensibly, the idea is to get a product similar to wrought iron, but since the scrap does not undergo the same refining action as in making wrought iron, it follows that if the original scrap is of a mixed quality (as it usually is) the final product will not be homogeneous. Furthermore, examination often shows that the metal contains a great deal too much slag very badly distributed, thus unfitting the metal for a number of structural purposes.

Ingot iron is a very pure form of iron made in an open hearth furnace. In its manufacture, the elimination of carbon and other elements in the original metal is carried on to a much greater extent than in the making of ordinary low carbon steel, the final product containing less than .06% total impurities which is remarkably low. Thus we get a metal that is almost pure iron, and since it is made in an open hearth furnace in which a very high temperature may be obtained, the final metal exists in a molten state and can therefore be tapped out and cast into ingot form—hence the name ingot iron.

Keeping in mind these general outlines, it is comparatively easy to arrive at a conclusion as to some of the uses to which the products under discussion may be put. A consideration of a few of the principles that seem to underlie the cause of corrosion in iron will perhaps give us a better understanding of the discussion.

At the present time the evidence seems to point to the fact that the purer iron is the less likely to corrode. (The presence of manganese seems to enhance the corrosive actions.) Not only does the purity of the iron have a great effect, but the homogeneity also seems to be a great factor. The more homogeneous the iron or steel is the less likely it seems to be open to corrosive action. It is obvious, of course, that the purer the iron is the more likely it is to be homogeneous.

From the standpoint of resistance to corrosion, it is easy to see why wrought iron, being a very pure form of iron, might be specified in construction work. On the other hand, the bushelled product, with its lack of homogeneity, seems to be anything but suited to resisting corrosive action.

A knowledge of such facts as these has led engineers to be extremely careful these days when specifying wrought iron, especially as the true wrought iron industry seems to be on the wane in America in spite of production figures that are given out. (It is lately pointed out by good authority that these figures must include, in many cases, the product of the bushelling furnaces.) One often wonders why, if there is a demand for good wrought iron, the American firms do not protect themselves by stamping their iron, as do the English and Swedish makers. It is argued, of course, that a stamp is easily copied or wrongly used, but this merely adds force to the claim that, as far as wrought iron and the bushelled product are concerned, there is a loose tendency in America. This is augmented by the fact that in many cases the buyer is indifferent. The bushelled iron does the work just as well as the pure wrought iron, there being nothing at stake in most cases, and besides it is cheaper.

Through the tangle, though, there appears a good solution to the whole problem. If purity and homogeneity in the iron are what are desirable, the products to which we may give the name ingot iron seem to be admirably suited to the case. The name "ingot iron" has been used as a trade name, but a broader significance than a mere brand should be placed on it. If the corrosive question is to be solved, it would seem at present that it must be done so by using these pure irons (in reality very pure steels) made in open hearth furnaces. To such irons as these then, let us apply the term ingot iron. Be the outcome on this point what it

may, it behooves the engineering public to investigate thoroughly the general good qualities of such a product as herein outlined as ingot iron."

THE PRESERVATION OF IRONWORK.

Ironwork enters so largely into the everyday life of municipal engineers, and is used in so many forms in works of construction, that a little consideration given to the methods and need for its preservation may be of service in understanding the principles that are involved.

William Ransom in The Surveyor and Municipal and County Engineer sums up some of the principles underlying the preservation of ironwork from rusting as follows:—

The oxidation or rusting of iron is not due simply to the combination of iron and oxygen. Iron under ordinary atmospheric conditions will quickly rust, but in the presence of dry oxygen will remain bright for a long time. Rusting appears to require not only air, but moisture and carbonic acid. Lime will prevent iron rusting quickly, because it absorbs the carbonic acid which is always present to some extent in the atmosphere.

During the process of rusting ammonia is formed through the nitrogen of the air combining with the hydrogen of the water. The oxide of iron, or rust, as it forms, sets up a galvanic action with the unaffected metal, and although a very weak current of electricity is produced, it decomposes the water, allowing the hydrogen to combine with the atmospheric nitrogen. This galvanic action causes the corrosion of ironwork to proceed with increasing rapidity, after rusting has once been allowed to commence.

The action of water upon iron depends largely upon the presence of carbonic acid. In the presence of sea-water the iron may be dissolved without the formation of visible rust. Sewage matter has a greater action upon iron than ordinary water, probably due to the presence of sulphides.

One of the principal causes of accelerating rusting is electrolysis. When the iron is brought into contact with another metal in the presence of a solution or atmosphere through which an electric current can pass, one metal will decompose. When iron railings are fixed by means of molten lead, the iron will decompose, especially if moisture be often present. This action can be seen in almost all cases where railings have been thus fixed for any length of time.

It will thus be realized how necessary it is that ironwork which has to do duty for many years should be preserved from rusting. In works of construction, unless precautions were taken, the strength of ironwork would speedily be reduced below the factor of safety.

Ironwork can be protected from rusting by (1) coating with oxide films, (2) coating with paint or varnish, (3) coating with some other metal, and (4) enamelling.

(1) When super-heated steam is allowed to pass over red hot iron the water vapor is decomposed, the oxygen combines with the iron, and the hydrogen is liberated. The oxide which forms on the iron makes a protective coat or film against future oxidation. This has become known as the Bower-Barff process, from the two manufacturers who most successfully applied the process. The oxide which is formed is the magnetic oxide Fe_3O_4. If the coat or film becomes broken, or is imperfectly formed, galvanic action would cause corrosion of the iron.

(2) Ordinary paint will form a preservative for ironwork, especially when the base used for the paint is red oxide of iron. Red and white lead are both used, but are likely to be acted upon by carbonic acid gas, etc., and galvanic action also may occur. Paint should be applied to cast-iron as soon as possible after it has been [illegible] before rust has had time to form. The cast-iron should first receive a coat of linseed oil before the paint is applied cold. Various patent preparations [illegible] are now on the market for the preservation of iron. These are largely used for the painting of railings and outdoor ironwork, and are found to last longer than ordinary paints.

Bituminous varnishes are most commonly in use for the preservation of iron pipes, etc. They consist of various mixtures of coal-tar, pitch, linseed oil, resin, and the like. Dr. Angus Smith's process is the best known, and consists of first cleaning the iron, heating to 700 deg., and then dipping for fifteen or twenty minutes into his mixture at a temperature of between 300 deg. to 400 deg.

(3) Iron can be coated with another metal—such as zinc or tin. Iron is coated with zinc by the process of galvanizing, which consists of first cleaning the iron by steeping in an acid solution, and then plunging into molten zinc, which forms a protective coat to the iron. If, however, the zinc be worn off or the coat imperfectly formed, galvanic action is set up, which will corrode the zinc. Zinc is very readily acted upon by acids, and is therefore not suited to manufacturing districts. When iron is coated with tin, if galvanic action is allowed to set up, the iron is corroded.

(4) Enamelling is only of value for iron articles used for domestic purposes, and consists in applying a pottery glaze, which should contain very little lead. Where the enamel becomes chipped the exposed iron will quickly rust and cause further disintegration of the enamel.

CAST-IRON AND STEEL PIPE.*

By Nicholas S. Hill, Jr.

My remarks will be confined, as were those in the paper under discussion, to the relative value of cast-iron and steel for large supply mains, as nothing has been developed which so readily adapts itself to street distribution mains of smaller size as does cast-iron.

In first cost steel mains of large size are cheaper than cast-iron mains. As a rule they are more easily handled because lighter.

The question of strength is one of design; and in making comparisons it should be assumed that both the cast-iron and riveted-steel pipe will perform the function for which they are designed.

From the data available, it appears that the cost of maintenance and depreciation on cast-iron pipe is less than on riveted-steel pipe. The data at hand, however, is not sufficient to enable one to say definitely that the difference is sufficiently great to offset the difference in interest charges resulting from the additional first cost of the cast-iron pipe. Interruptions to service where a community depends upon a single supply line, resulting from repairs as a result of corrosion, are usually of more importance, however, than the mere consideration of cost.

Experience has shown that the more nearly steel approaches a pure iron, the longer it resists corrosion. The properties of wrought-iron are the nearest approach to pure iron, notwithstanding its slag. This is because the slag is mechanically mixed and does not interfere with the chemical properties of the product.

Investigations by a Committee of the American Society of Testing Materials have failed to produce any conclusive

*Abstract of discussion of paper by Mr. Allen Hazen, M. Am. Soc. C.E., read before the American Water Works Association in June, 1911.

evidence with regard to the relative rapidity with which wrought-iron and steel corrode; so many elements seem to affect the rate of corrosion. Field experience, however, indicates that the riveted pipe of wrought-iron is more resistant than steel. In considering this question, it must be remembered that it is difficult to obtain wrought-iron plate at this time, and that in specifying riveted pipe, low carbon steel should be considered.

Cast-iron is more highly resistant in corrosion than either steel or wrought iron. Every examination which I have made of steel and cast-iron mains, laid under the same conditions, has fairly demonstrated the greater resistance of cast-iron pipe to corrosion.

The greater resistance of cast-iron to corrosion than steel is probably due, in a large measure, to the silicious coating which it receives when the molten metal is poured in the mould. The silicious coating adheres very firmly to the pipe. Also the roughness of the exposed surface of the cast-iron offers a firmer foundation for the coating than does the smooth surface of the steel pipe, and hence the same coating applied to cast-iron is usually more durable than when applied to steel pipe.

We have much data with relation to the life of cast-iron pipe. We know that it is good for a hundred years when properly coated, and under almost any condition of soil. There are instances of much longer life.

The intake pipe at the first pumping station for supplying Paris (which extended into the River Seine, and which was laid in 1802), after an immersion lasting for over a century, was recently removed and was found to have been in such good condition that it might have been relaid. The lettering on the pipe was not disturbed. Instances of cast-iron pipe laid in Europe as early as 1765, which is now in serviceable condition, have been recorded. The speaker has removed cast-iron pipe from low ground saturated with a salt solution which had been in service since the early part of the last century and which was in excellent condition when removed. There appears to be no practical limit to the endurance of cast-iron pipe and its resistance to ordinary corrosion.

In considering the effects of corrosion, reference must be made to the effects of chlorides, nitrates and sulphates, which are found in soils of high organic content, and in marsh lands adjacent to salt water. Weak solutions of these salts will produce harmful effects, proportionate to the rapidity with which a material will corrode. A minute quantity of soluble salts is sufficient to start corrosive action and a material which is liable to corrosion should not be placed therein.

Reference has been made to the life of cast-iron pipe. Experience with riveted-steel pipe is very much more limited but there are examples which tend to show that lines of riveted-steel pipe, constructed within the last twenty years, have materially depreciated and great trouble has been experienced from the effect of corrosion. These effects seem to proceed more rapidly in clay soils and marsh land than in sand. Among the pipes which have thus been affected, is the second Hemlock Lake conduit, in Rochester (N.Y.), which was laid in 1893; the Portland (Ore.), conduit, the Atlantic City conduit, and certain conduits laid in the marshes of the Hackensack meadows in New Jersey.

Electrolysis is manifestly more rapid on steel pipe than the cast-iron is several times as thick, will, owing to the rapidly than cast-iron, and electrolysis may be defined as a more serious form of corrosion, occurring where an electric current leaves the pipe and which, in so doing, sets up corrosive electrolytic action.

Rolled steel plates, as compared with cast-iron, although the cast-iron is several times as thick, will, owing to the higher conductivity of steel, have from one to three times the conductivity of a cast-iron pipe designed for the same pressure. This is important, as the electrolytic action is mainly dependent upon the volume of the current, and hence in territories where street railway currents are returned over pipe lines, the riveted-steel pipe offering a better conductor will carry more current, and hence electrolytic action will be aggravated on this account.

There are few places of any size, in which the suburbs are not, at the present time, traversed by numerous suburban lines. If the mains pass in the vicinity of these lines, they may absorb their proportion of the return trolley current and deliver it to the ground at some point nearer the power station. This was clearly demonstrated to me in a recent survey of certain steel and cast-iron pipe lines laid in the marshes of the Hackensack meadows. I found that these pipes were carrying quite an appreciable quantity of current from distant points to the power station, and that they were unloading it in the marshes, to be returned through the saturated soil, to the power station. The result of these surveys indicated the superior conductivity of the steel pipe, and the much greater corrosion resulting from the effects of electrolytical action, than in the case of the cast-iron mains.

In summing up, it may be said: (1) That where first cost is of prime importance, steel may be used on large supply mains. (2) Where the difficulties of transportation are serious and the cost of hauling is heavy, expediency may call for the use of this material. (3) In sections where dry sandy soil is encountered, one would be justified in securing the benefit of reduced first cost by recommending steel pipe. (4) In clay and wet soil, such as marsh lands and meadows, particularly where the presence of salts in solution increases corrosion riveted-steel pipe should not be used. (5) Where pipe is laid in wet soil and will be subject to electrolysis, cast-iron should be used. (6) Where permanency is a prime consideration, our present knowledge indicates that cast-iron is preferable.

THE INFLUENCE OF ELECTRICAL SMELTING OF IRON ORE ON THE SWEDISH IRON INDUSTRY.

At a discussion on the above subject which took place at the Jubilee Meeting of the Technical Association, at Stockholm, the following views were expressed:—

Mr. Arvid Johansson said that the whole of the present pig-iron output might easily be produced by the aid of 180,000 h.p. By adopting electrical smelting this would mean that 60 per cent. of the total quantity of charcoal now used could be saved. The Province of Norrbotten, or the northern part of the country, on the whole offered the widest scope for the development of electrical smelting, (1) because the iron ore was cheaper there; (2) because there were fewer consumers of the available electrical energy; and (3) because there was a cheaper supply of charcoal. The central part of Sweden also offered a vast field for electrical smelting. For instance, after harnessing the Dalelfoen only (the valley river), there would be 250,000 h.p. available for industrial purposes, of which 135,000 h.p. would belong to the Stora Kopparberg Company.

Major-General Geijer (Vice-Chairman of the Grängesberg Company) expressed great faith in the development of an electrical iron industry in Norrland. In regard to Norway, he thought that country was placed at a disadvantage in regard to its capacity to compete with Sweden, chiefly owing to the higher percentage in sulphur of the Norwegian iron ores.

Director Stridsberg, of the Trollhättan Works, said that after the completion of the Trollhättan Canal, which would connect the central parts of the country with the sea, there would be no difficulties in the way of a large export trade in pig-iron to be started. He was an advocate of placing a tax on ore for export.

Director Hult pointed out that the iron industry in Central Sweden was threatened with keen competition from the iron-sponge process at the Höganäs Works.

Director Sahlin called attention to the imports of German pig-iron, which were steadily on the increase.

Director Amilin emphasized the injurious policy of utilizing semi-products from abroad, whereby the quality of Swedish goods would suffer.

Director Wahlberg, of Fagersta, did not share this pessimistic opinion, and thought that the Swedish iron-masters were not so easily led astray.

NEWS ITEMS.

It has been reported that cinnabar has been recently found in the Porcupine region. Cinnabar, the ore of mercury, would be a lucky find in the district mentioned.

* * * *

We have an enquiry for a second-hand analytical chemist's balance. Address replies to Editor "Metallurgical Comment."

MONTREAL STREET RAILWAY.

It is generally allowed that the complaints which began to be heard some time ago against the Montreal Street Railway were probably the outcome of the change of ownership of the railway. There is no denying that the service is becoming gradually less effective, and that, at the present time, it is less satisfactory perhaps than ever before since its electrification. During the last fiscal year of the company, the number of tickets and transfers amounted to upwards of 150,000,000, this being an increase of some 15,000,000, or 10 per cent. on the number collected in 1910. During the same period it is hardly likely that the efficiency of the railway increased ten per cent., so that though the company operated fully as many cars and as good cars as during the last year of the old regime, and operated them as rapidly as the previous year, the congestion would still be approximately ten per cent. greater. It is not thought that the company added to its rolling stock and otherwise increased its efficiency proportionately with the increase in population. In reality, this question of increase in population in Montreal raises some very serious considerations. The price of real estate has advanced considerably during the past year, which one must attribute in large part to incoming population.

In the vicinity of Montreal houses are being erected in all directions, extending for miles out into the country wherever any sort of tramway connection can be had. This makes the work of the tramway company much more difficult than it was a few years ago. The fear in Montreal seems to be that some considerable expenditure may be put out upon schemes for more rapid transit, which will become almost totally inadequate before they are finished. Meantime nothing is being done, and the car lines become more crowded daily and the citizens experience ever-increasing difficulty in getting accommodation.

A resolution was adopted by the special civic committee having charge of this street railway question during the past week, by which it is proposed to ascertain how many large cars the tramway company is employing on its routes, the total number of cars available, and the number of improved cars which have been added during the past five years. Certain questions concerning less frequent stops will be asked, and suggestions will be made as to new streets and new plans to facilitate the operation of cars. Among citizens the [illegible] of these suggestions to meet the situation which is [illegible] keenly felt.

WINNIPEG BUYS AMERICAN CEMENT.

Last week the Board of Control in Winnipeg accepted the tender of the Lehigh Portland Cement Company of Chicago for 25,000 barrels of cement to be delivered as required in 1912. The tender of the Lehigh Company, the lowest of five submitted, will give Winnipeg its cement supply for next year at a net price of 60 cents per 100 pounds net weight, laid down in Winnipeg, excluding sacks, which will be returned at the cost of the manufacturer. This means a saving of 14 cents per barrel of 350 pounds on the price paid during the present year.

The actual price which the city will pay the Lehigh Portland Cement Company of Chicago for its supply next year may be less than the price submitted, as the company has agreed that if there is any reduction in duty or any revision of freight rates, the city will be given the benefit of reduction. This, it is understood, will include the rebate of two cents per barrel on sacks returned to the United States, which it is expected can be collected, and if this is done will increase the saving over last year's prices to 16 cents per barrel.

PERSONAL.

Mr. A. J. Latorned, city engineer for Edmonton, Alta., has forwarded his resignation to the municipal commissioners. Mr. Latorned cites an offer from another city as his reason for resigning.

Dr. J. W. S. McCullough, Provincial Health Officer, and Mr. N. J. Ker, City Engineer of Ottawa, are on a tour of the principal United States cities, inspecting water and sanitary methods. The City of Ottawa is preparing to install water and sewage systems that will in the future protect the citizens from a recurrence of a typhoid outbreak such as the one of last year, and the information gathered by Dr. McCullough and the city engineer will largely determine the kind of system to be constructed. In Ottawa Dr. McCullough and City Engineer Ker will consult with Mr. Allen Hazen, the sanitary expert.

Mr. Arthur St. Laurent, deputy minister of public works and engineer in charge of the Georgian Bay Ship Canal, has left Ottawa in company with Mr. Coultlee, the assistant engineer of the Georgian Bay Ship Canal, for Panama, via New Orleans. The object of the two engineers is to examine the works and obtain information that may be useful when the Georgian Bay Ship Canal is placed under construction. The two gentlemen will be absent from Ottawa for six weeks, and during that time will consult with all the eminent engineers who made possible the opening of the Panama route, as the latest machinery and appliances for work of that kind are at the canal. Mr. St. Laurent and his assistant will make a report on them.

Mr. F. A. Yerbury, formerly with the Canadian Boving Co., Ltd., has severed his connection with that company, having accepted an appointment with a new company in Vancouver, known as the Heaps Engineering Co., Ltd., the president of which is E. H. Heaps, a gentleman well known throughout British Columbia, from his long connection with industrial concerns there. This new company will install rolling mills, and probably will put in the first electric steel making furnace in Canada of the well known Gronwell type. They will also manufacture motors of the internal combustion type for marine and automobile purposes. Mr. Yerbury will be remembered as the man who had the privilege of introducing the Diesel engine into Canada, of which there are quite a number now in successful operation.

FORESTRY CONVENTION.

The members of the Canadian Forestry Association and others interested in forest conservation will on February 7th and 8th, 1912, gather in Ottawa to discuss what they hope will be the most practical programme of any of their conventions.

H. R. H. the Duke of Connaught evinces his interest in the subject by extending his patronage to the gathering, and the concern of the government is shown in the fact that the meetings will be held in the Railway Committee Room of the Parliament Buildings, and that a number of parliamentary leaders will be in attendance. The railways have granted special rates.

On the evening of February 7th a banquet in which the members of the Canadian Lumbermen's Association will participate with the Forestry Association, has been arranged. The lumbermen will hold their annual meeting in Ottawa on February 6th, and it is expected they will attend in large numbers to discuss with the members of the Forestry Association matters respecting fire protection, logging methods and regulations which vitally affect them, and which are also of concern to every taxpayer in Canada.

Details are now being worked out by the committee in charge, of which Mr. James Lawler, Canadian Forestry Association, Ottawa, is the secretary, and from him may be obtained any needed information.

COMING MEETINGS.

THE AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—January 16th, 1912, Annual Meeting, Aldine Club, Fifth Avenue and 23rd Street, New York City, at 8 p.m. Secretary, Eugene W. Stern, 103 Park Ave., New York.

CANADIAN FORESTRY ASSOCIATION.—February 7th and 8th, 1912. Forestry Convention Meetings held in the Railway Committee Room, Parliament Buildings, Ottawa. Secretary, Mr. James Lawler, Canadian Bldg., Ottawa.

CANADIAN LUMBERMEN'S ASSOCIATION.—February 6, 7 and 8, 1912. Annual Meeting to be held at the same time and place as the Canadian Forestry Association.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Jan. 24, 25, 26, 1912, General meeting, 413 Dorchester St. West, Montreal. Prof. C. H. McLeod, Secretary.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain, Acting Secretary; E. A. James, 57 Adelaide Street East, Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King's Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secretary, Mr. Heal, Moose Jaw

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Charles Kelly, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President. Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary, H. Mortimer-Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, T. A. Starkey, M.B., D.P.H., Montreal. Secretary, F. C. Douglas, M.D., D.P.H., 51 Park Avenue, Montreal.

CANADIAN RAILWAY CLUB.—President, H. H. Vaughan; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary, R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Alfred T. de Lury, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, Grant Hall; Secretary, W. H. Rosevear, 199 Chestnut Street, Winnipeg Man. Second Monday, except June, July and August at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page
Medicine Hat, Alta., church	Jan. 20.	Dec. 28.	59
Ottawa, Ont., iron posts	Jan. 31.	Dec. 21.	68
Ottawa, Ont., wharf, Evandale, N.B.	Jan. 8.	Dec. 21.	59
Ottawa, Ont., coverings for piping	Jan. 3.	Dec. 21.	59
Ottawa, Ont., rails and rail fastenings	Jan. 10.	Dec. 28.	68
Ottawa, Ont., breakwater, Devil's Island, N.S.	Jan. 11.	Dec. 28.	59
Toronto, Ont., sewers	Jan. 16.	Dec. 28.	70
Westmount, Que., road roller and bituminous macadam mixing plant	Jan. 3.	Dec. 14.	58
Westmount, Que., road roller and macadam mixer plant	Jan. 3.	Dec. 21.	68
Winnipeg, Man., supply of fire hose	Jan. 8.	Dec. 14.	59
Winnipeg, Man., drawings for government buildings		Dec. 21.	68
Winnipeg, Man., motor generator set	Jan. 22.	Dec. 21.	59
Woodstock, Ont., church	Jan. 15.	Dec. 21.	59

TENDERS.

Hamilton, Ont.—Plans have been prepared and a company is being organized to turn the old St. Lawrence Hall property into a modern apartment building.

Montreal, Que.—Tenders will be received until January 9, 1912, for 3,000 tons of unbroken macadamizing stone and 6,000 tons of unbroken concrete stone. Copies of specifications may be obtained upon application to Mr. F. W. Cowie, Chief Engineer. David Seath, Secretary Harbor Commissioners of Montreal, Montreal.

Ottawa, Ont.—Tenders will be received until January 15, 1912, for supplying 10,000 cubic feet of round yellow spruce in the log, and 40,000 cubic feet of round white pine timber, all in accordance with specifications prepared by the Dept. of Marine and Fisheries, delivered at Sorel, P.Q. Specifications, etc., can be obtained from the Purchasing and Contract Agent, Dept. of Marine and Fisheries, Ottawa, and from the Director of Shipyard, Sorel, P.Q. Alexander Johnston, Deputy Minister of Marine and Fisheries, Dept. of Marine and Fisheries, Ottawa.

Ottawa, Ont.—Tenders will be received until January 15, 1912, for the construction of a wharf at Anse Aux Canards, Gaspe Co., Que. Plans, etc., may be seen at the office of the District Engineers, Quebec, Montreal, and on application to the Postmaster at Newport, Que. R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until January 15, 1912, for the delivery of Indian supplies during the fiscal year ending the 31st of March, 1913, duty paid at various points in Manitoba, Saskatchewan and Alberta. Particulars may be had on application to J. D. McLean, Asst. Deputy and Secretary, Dept. of Indian Affairs, Ottawa.

Ottawa, Ont.—Tenders for the construction of a public wharf at New Liskeard, District of Nipissing, Ont., will be received until January 10, 1912. Plans, etc., may be obtained at the offices of J. G. Sing, Esq., Dist. Engineer, Confederation Life Bldg., Toronto; on application to the Postmaster at New Liskeard, Ont., and at the office of R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Toronto, Ont.—Tenders will be received by the chairman of the Board of Control, until noon Tuesday, January 16th, 1911, for the supplying and driving of timber sheet filing at the Sewage Disposal Works site. G. R. Geary, Mayor, Chairman Board of Control, City Hall, Toronto. (See advertisement elsewhere in the Canadian Engineer).

Victoria, B.C.—Plans for the new steel bridge to span the South Thompson River at the city of Kamloops are completed and it is expected that tenders for the erection of the structure will be called for very shortly.

Walkerton, Ont.—Tenders will be received until January 23, 1912, for the erection of a steel bridge over the Saugeen River, 10th Concession, Township of Brant. Bridge to consist of two spans of 125 feet each and one span of 90 feet, or two spans of 165 feet, 16-ft. roadway and with concrete floor. Specifications may be seen at the office of James Warren, Engineer in Charge, Walkerton.

CONTRACTS AWARDED.

Hamilton, Ont.—The contract for the glass factory for the Diamond Flint Glass Co. on James street north, has been awarded to the H. L. Dickinson Construction Co., Pittsburg, Pa. Estimated cost, $40,000.

Montreal, Que.—The Board of Control have awarded to Messrs. T. Lessard & Son, the contract for the construction of a fire and police station in Villeray, for $72,000.

Halifax, N.S.—The Berlin Woodworking Company has been given the contract of finishing the interior of the post office, and have sub-let contracts for parts of the work to Messrs. Falconer and McDonald. The contract price for the completion of the work is about $15,000.

Saskatoon, Sask.—Mr. B. Lancaster of this city, has the contract for additions and alterations at the Empire Hotel, the work costing in the neighborhood of $80,000.

Port Arthur, Ont.—Messrs. John S. Metcalf & Co., of Montreal and Chicago, have received the contract from the Grand Trunk Pacific to erect another 2,500,000 bushel unit to their elevator on Mission Island. Estimated cost, $500,000,

Vancouver, B.C.—Messrs. J. McDiarmid & Co., 138 Portage avenue, Winnipeg, have received the contract for the erection of a six to ten-story warehouse and cold storage plant on Water street for Messrs. Swift & Co. Estimated cost, $300,000.

Victoria, B.C.—The Westholme Lumber Company have received the contract for the Sooke Lake Waterworks, their price being $1,169,720. This was the lowest tender of the nine that were received for the complete work, including a reinforced concrete pipe between Sooke Lake and Humpback reservoir, and a riveted steel pressure pipe line from Humpback reservoir to the city.

Victoria, B.C.—Mr. Thomas Stedham has the contract for the repair of Smith's Hill reservoir, the contract price being $19,600. The contract calls for making water-tight the big receptacle and the construction of a wall ten feet in height through the centre of the basin, with necessary alterations to the intake and outlet pipes.

Windsor, Ont.—The contract for the construction of the new sewer on Tuscarrora street and Gladstone avenue has been awarded to Mr. Thomas Chick.

RAILWAYS—STEAM AND ELECTRIC.

Guelph, Ont.—The profits of the Guelph Street Railway for 1911 amounted to $7,449.

New Westminster, B.C.—Two new boats are under construction for the Grand Trunk Pacific Railway. These boats will be 140 feet long by 34 feet wide, stern wheelers, with a carrying capacity of 250 tons each. Two barges will be built in addition, and each boat, with a barge in tow, will have a carrying capacity of 500 tons of cargo each trip. The engines for these boats have been removed from the "Conveyer" and "Operator," which have been operated on the Skeena River for the past two years, and will give these boats a speed of fifteen miles an hour.

Ottawa, Ont.—At the operating sittings of the Board of Railway Commissioners, to be held in Ottawa on Tuesday, February 6th, 1912, commencing at ten o'clock in the forenoon, the board will consider the matter of requiring all railway companies subject to its jurisdiction to equip their locomotive engines with dump ash pans, or other appliance, to avoid the necessity of enginemen or others going underneath to clean the same.

Montreal, P.Q.—From 1,000 to 1,500 more miles of telephone train despatching circuits will be put into operation by the Canadian Pacific Railway during the coming year. The system of despatching trains by telephone has proved entirely satisfactory. The C.P.R. now has 1,000 miles of telephone wires in use for train despatching and is the second largest user of this method of despatching trains in the world. The additions which will be made during 1912 will make it the largest. Practically all the main lines in the eastern division of the C.P.R., with the exception of the line to Ottawa, are using this method to-day. By means of the system it is possible to get telephonic connection with any train on the line. Every train carries a telephone and a long pole, which may be hooked to the wire along tthe right of way whenever the need arises.

Thamesville, Ont.—Locomotive No. 1890, of the Mogul type, on a westbound Wabash freight exploded. The explosion was terrific, awakening the whole town and burning pieces of debris were blown blocks from the tracks. The whole body of the engine was blown several yards ahead of the lower part of the engine and turned completely upside down, parts of the car being found yards away. The exact cause of the explosion is not known.

Winnipeg, Man.—The Canadian Northern Railway have hauled wheat in large quantities to their elevators at Port Arthur and also to the Atlantic seaports. The total number of bushels of wheat marketed at points along the company's lines this year is 38,750,000 bushels, against that of twenty-four million bushels marketed last year for the same period, which shows an increase of fourteen million bushels. The Canadian Northern Railway have in store in their interior elevators eight million bushels of grain, while last year, for the same period, they only had three and three-quarter million bushels.

LIGHT, HEAT AND POWER.

Brockville, Ont.—To encourage the erection of uniform cluster lamps for street lighting, the board of light commissioners have decided to allow a special discount of 25 per cent. off present net current rates (10c. per K. W. H. for current used in same and for window lighting when said window lights are used only when lamp standards are used and connected with same meter.

Dundas, Ont.—A defective insulator in the hydro-electric station at this point, was indirectly the cause of the death of one workman and serious injury to another. During the light load period of January 1st repairs were undertaken with the above mentioned results.

Guelph, Ont.—According to the new electrical rates customers will have to pay a minimum charge of $5. It is the Commissioner's intention to keep the minimum charge in Guelph at $5 for the present at least, the reduction over the old basis will be from twenty-two and one-half to twenty-five per cent. Some customers will have a greater reduction on account of being larger consumers. The rates they are adopting at the beginning of 1912 are a fraction lower than any other city outside of Toronto and London, Ont. The net charge has been nine cents; the average price now will be between six and seven cents. The churches will have a reduction of from nine cents to six cents, the hotels will average a little over six cents, the stores and houses between six cents and seven cents.

Hamilton, Ont.—A report states that the Mackenzie and Mann interests will take over the Dominion Power and Transmission Company and all its holdings, including the Hamilton Street Railway, the Brantford and Hamilton Railway, Grimsby and Beamsville Railway, the Hamilton and Dundas Railway, the Hamilton, Burlington and Oakville Road, and the Cataract Power Company.

Hamilton, Ont.—Needle ice getting in the flumes at the De Cews Falls generating plant of the Dominion Power and Transmission Company caused considerable trouble recently. The city was in darkness one night, all traffic on the street railway and suburban roads being tied up. Hamilton's industrial establishments were helpless, and thousands of people were thrown out of work. Similar trouble last year tied things up for several days, causing heavy loss to the company, manufacturers, and thousands of men.

Port Dalhousie, Ont. — The Maple Leaf Rubber Company, who have been supplying this municipality with light for some time, have come to an agreement with the town authorities whereby the supply will not cease until further negotiations may be undertaken.

St. Thomas, Ont.—The hydro-electric service has been interrupted at intervals of late owing to defective wiring between London and Woodstock. The cause for the interruption, it was thought, could be traced to a broken insulator, which there are some reasons to believe was wilfully smashed on the line wire by a rifle shot.

Victoria, B.C.—A compromise may be reached between the city and the British Columbia Electric Railway Company with regard to the dispute over light and power rates. The city's contention is that the new rates agreed upon should have gone into force when the Jordan River power plant was completed on October 12 last. The company's contention has been that the new rates are not effective until a new ten-thousand horse-power plant has been installed at Jordan River, which will be next September. The company wrote to the city offering to put the new rates in force on March 1. The City Council replied that the threatened legal proceedings will be dropped if the date is made February 1, 1912.

Winnipeg, Man.—An announcement of a big reduction in light and power rates has been made. This matter has been pending since the opening of the new civic power plant and final action was taken by the city council and board of control in joint session. The rates fixed were three and a third cents per kilowatt hour for light, with a ten per cent. discount for cash, which places the price for light at less than three cents per kilowatt hour. The minimum charge per month was fixed at fifty cents, as against one dollar charged previously. The Winnipeg Electric Railway Company's rates have been ten cents per kilowatt hour up to a recent date, when it was lowered to seven and a half cents. Power rates fixed by the city range from a quarter of a cent. to one and a half cents per kilowatt hour. These prices work out on a basis of cost so far below that which was obtained heretofore that the citizens on the whole are highly pleased over the matter.

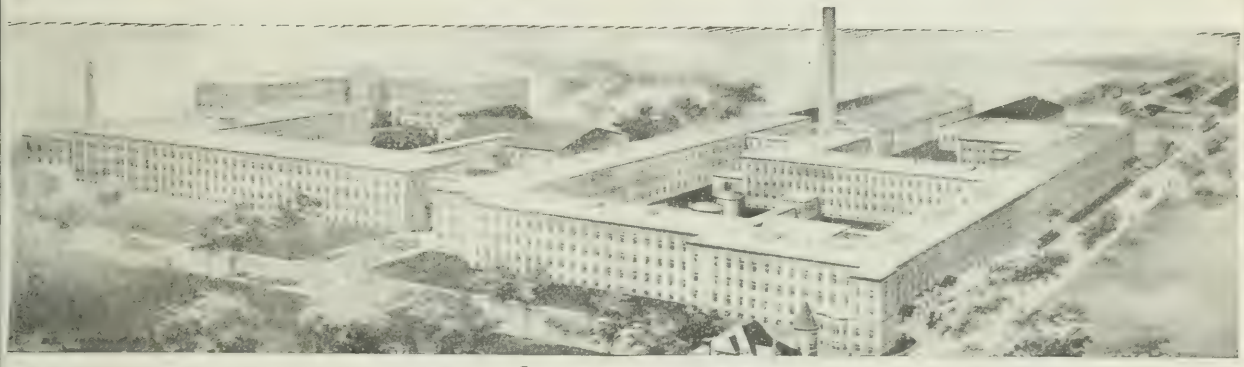
SEWAGE AND WATER.

Merriton, Ont.—The municipal receiver was out of commission one day last week, owing to anchor ice at the intake pipe.

Chatham, Ont.—The Civic Waterworks Department is handing over a surplus of $3,500 to the city after an exceedingly successful year, characterized by decreased cost of maintenance and considerable extensions to the plant.

Sarnia, Ont.—The intake pipe has been found to be broken at a point about 200 feet from shore. A diver discovered that the pipe had been dragged north about twelve feet, so that the connection was completely severed. From appearance the intake had evidently been in that condition for some time, the pipe not having been inspected for the past three years.

Barrett Specification Roofs



Warner Bros. Co., Corset Manufacturers, Bridgeport, Conn. Day & Zimmerman, Engineers, Philadelphia, Pa.

The Most Economical Roof

FOR half a century architects have known that slag and gravel roofs would *often* show marvelous durability.

The Barrett Specification defines the method by which these roofs may be built so that they will *always* show such durability.

It provides for the best materials manufactured, and prescribes the most approved methods of application.

A Barrett Specification Roof will cost less than any other permanent roof, will last upwards of twenty years and will need no painting or coating or care. Such roofs are fire-retardant and take the base rate of insurance.

That is why they are invariably used on large manufacturing plants where the roof areas are great and where, therefore, the unit costs are carefully studied.

Booklet giving the Barrett Specification in full mailed free on request. Address nearest office.

Special Note

We advise incorporating in plans the full wording of The Barrett Specification, in order to avoid any misunderstanding.

If an abbreviated form is desired however the following is suggested:

ROOFING—Shall be a Barrett Specification Roof laid as directed in printed Specification, revised August 15th, 1911, using the materials specified, and subject to the inspection requirement.

The Paterson Manufacturing Co., Limited

Montreal Toronto Winnipeg Vancouver St. John, N.B. Halifax, N.S.

CURRENT NEWS.

Brantford, Ont.—The by-law to raise $85,000 for the improvement of the John H. Stratford Hospital was carried by nearly 500 majority.

Bracebridge, Ont.—The by-law for a loan of $60,000 to the Dominion Linen Mills, Ltd., was defeated.

Brampton, Ont.—The by-law to purchase the Brampton Electric Light franchise was carried by a majority of 140.

Berlin, Ont.—The by-law to raise $100,000 for extensions to the waterworks system was carried by 576 majority. The by-law to raise $10,735 for the deviation of Wilmot raise $125,000 for storm sewers, the vote being 1,269 to raise $10,000 to purchase additional appliances and equipment for the fire department, including a motor truck, was defeated by 163 majority. The by-law to raise $7,400 for meeting the expense incurred in making extensions of the Berlin & Waterloo Street Railway was carried by a majority of 344. The by-law to raise $1,700 for a trunk sewer was carried by a majority of 302.

Barrie, Ont.—The by-law to raise $50,000 for improvements to the Barrie Collegiate Institute was beaten by 581 to 238. The by-law to raise $35,000 for sewers carried by 571 to 269.

Clinton, Ont.—The two by-laws voted on both carried: Hydro-electric by-law, majority 109; good roads by-law, 123 majority.

Edmonton, Alta.—A suggestion has been made to conduct the municipal scavenging department differently than it has been in the past. It will be made a separate department from the medical health officer's department, and conducted along different lines. The reason given for such a change was that the scavenging work is not being properly done. Several instances are recorded where refuse is not cleaned up, and also in the backyards of several citizens where the refuse is not burned, thus becoming a menace to the public.

Edmonton, Alta.—A company is forming to operate certain gravel pits adjoining the city. The company's officers are in communication with the commissioners asking if the city would allow the company running rights over the street railway tracks to the company's stations and depots for the carriage of freight; if the city would allow running rights over the railway for the supply of gravel and coal; and if the city would allow the company the privilege of the tracks for delivery of coal and gravel at special points within the city. The letter was written to enable the promoters to arrive at a correct estimate of the value of the proposal which they have in hand at the present time.

Edmonton, Alta.—The municipal telephone department in November netted a surplus. The revenue was $7,129.46, and the expenditure $5,722.38, thus showing a surplus of $1,407.08 for the month. The grand surplus for the year amounted to $32,219.01. The capital receipts, including balance on hand, amounted to $8,137.31. The capital expenditure was $4,448.42, against $1,705.65 in 1910.

Fort William, Ont.—The committee controlling the public utilities, consisting of electric light, water and telephones, have a surplus of $10,105 on the yearly operation of the combination. The gain of the electric light system amounts to $12,270.21, the water department $1,000, and the telephone system shows a deficit of $3,165.21.

Guelph, Ont.—The by-law to erect a new fire hall, equipped with auto apparatus, was defeated by 589 votes. The by-law to further extend the street railway in St. Patrick's Ward was carried by 623 majority. The by-law to place the sewerage and public works under a commission, carried.

Hamilton, Ont.—The Steel Company of Canada intend to open two new hearth furnaces of fifty tons capacity a day, also a blooming mill, a continuous billet mill and a combination rod and bar mill. They will be in operation by next October, employing a thousand additional skilled workers. Later on it is intended to erect factories for finishing wire goods. The extension will cost $2,000,000.

Hamilton, Ont.—By-laws to raise $833,000 were submitted, and the electors carried all but one, that to purchase the Oaklands property on the north shore of the bay, at a cost of $40,000. They authorized an expenditure of $793,000 as follows:—Waterworks extension, $650,000; east end park, $60,000; central fire station, $65,000; Gore Park convenience, $14,000. The vote was:—Waterworks, 3,705 for, 1,169 against; east end park, 2,353 for, 1,965 against; fire station, 2,903 for, 1,468 against; Gore Park, 2,922 for, 1,608 against.

Ingersoll, Ont.—The $125,000 by-law for the purchase of the waterworks was carried by a majority of 48.

Lethbridge, Alta.—The commission sitting at Lethbridge to arbitrate on the recent differences in mining matters between the United Mine Workers and the Western Coal Operators Association, have forwarded their report to Ottawa. The question of wages occupied a prominent part in the proceedings, and the following has been recommended to apply to Maple Leaf Coal Company, Bellevue, Alta.:—

	Per Day
Minimum wage	$3.00
In Parallel airway old mine	6.35
In Angle Chute old mine	3.50
Parallel airway	5.90
Pillar work (per cubic yard)	0.43

London, Ont.—The ratepayers voted in favor of all but one of four by-laws. The by-law to be defeated was one to raise $125,000 for storm sewers, the vote being 1,269 to 2,272. A by-law to bonus the North Midland Railway for a radial terminal station to the extent of $65,000, was carried by a vote of 2,345 to 1,357. One to appropriate $20,000 toward a bridge from South to West London by 2,113 to 1,596, and a third, to spend $50,000 on a garbage system, by 1,883 to 1,816.

Montreal, P.Q.—A shack, in which was stored the civic dynamite, was destroyed, when the contents exploded in the early morning of December 31st last, a watchman narrowly escaped death. He was struck and knocked down by a piece of the flying timber and badly cut and bruised. Many windows in the immediate neighborhood (Rosemount) were smashed, and the explosion was heard in all sections of the city.

Montreal, P.Q.—The legislation committee of the city council has decided to petition the Provincial Government for power to grant franchises to automobile omnibus companies, with a view of relieving the present congestion on the street railway cars.

Ottawa, Ont.—Work on the new civic incinerator has been started. Many difficulties have had to be faced in this project, among which were legal differences regarding the transfer of the site.

Owen Sound, Ont.—The by-law to loan $20,000 to a nut and bolt factory was carried by a large majority, as were also the hydro-electric and gas extension by-laws.

Ottawa, Ont.—The by-law submitted to the ratepayers to vote a sum of money to obtain a water supply from McGregor Lake, was defeated, very few votes being recorded in its favor.

Port Stanley, Ont.—The plans of the $600,000 sea-wall which is to be constructed by the Dominion Government at the east side of Port Stanley harbor, which was decided upon by the Laurier Government at the last session of parliament, has been approved by the new Conservative Government, and the work will be proceeded with, it is expected, during the year. It is reported that the contract will go to a construction company now being organized by Mr. A. E. Ponsford.

Quebec, P.Q.—Dr. J. A. Beaudry, chief inspector, Province of Quebec, has gone to the provincial capital to be at the disposal of the authorities should need arise from the present alleged smallpox epidemic. Dr. Beaudry is considered an expert in smallpox diagnosis.

Renfrew, Ont.—A by-law to pay $60,000 for the further development of the power plant carried.

Ridgetown, Ont.—The canning factory by-law was carried in this municipality by a majority of 313.

Sarnia, Ont.—The Mueller Brass Company bonus by-law was carried by 1,407 for and 96 against. When the company have invested $100,000 in buildings, etc., and employ 100 men, they will receive a bonus of $20,000 and another $10,000 when 50 more men are employed.

Stratford, Ont.—The by-law to loan the Jennewitz Co. $10,000 to assist in starting manufacture of piano accessories, was defeated.

St. Thomas, Ont.—The by-law to raise $10,000 for an Isolation Hospital carried by 400 majority. The plebiscite on extending the Citizens' Street Railway to Port Stanley was given an adverse vote of 750.

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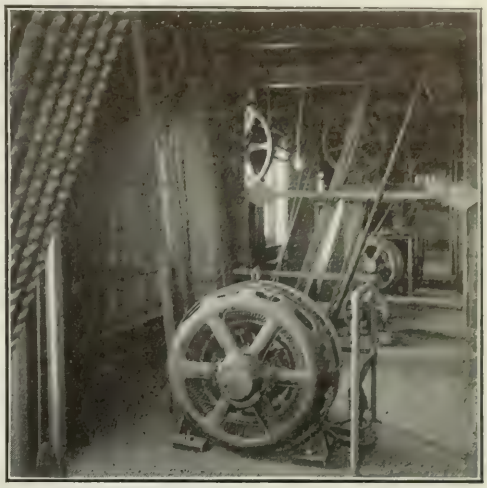

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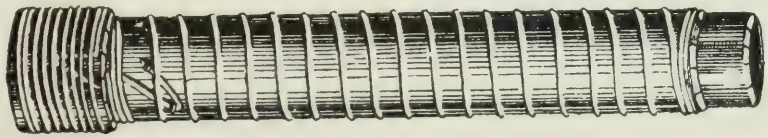

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Toronto, Ont.—An old twenty-four-inch water main burst just before midnight, New Year's eve. The break occurred between two railway tracks on the esplanade in the vicinity of John Street. In a few moments ten tracks were covered with water so that they could be counted only by means of the cars on the rails. The water spread from the Union Station to a quarter of a mile west. The workmen of the water service could not get to the main, so that the only way of fixing it was to shut off the main near the pumping station. The main was the first one laid in Toronto, and it was put in thirty-nine years ago. It was sunk ten feet under the tracks. At the time the break took place the pressure was 100 pounds to the square inch.

Toronto, Ont.—The ratepayers have voted to spend $2,200,000 on extensions of the hydro-electric scheme; $1,783,333 on an extension of Bloor street, and $139,488 on car line extensions.

Vancouver, B.C.—It is recognized that the Fraser River will supply all the waterfront that will be required by the expansion of Vancouver and the greater city that lies between Burrard Inlet and the Fraser. But before permanent improvements are carried out, it is the opinion of Mr. Louis Coste, civil engineer of Ottawa, who is on the coast on a mission for the Dominion Government, that a commission of engineers should be appointed to decide the best course of action. Tenders are being called for the construction of a jetty at the mouth of the Fraser. This is the recommendation of a prominent engineer, who stated that with this jetty, perhaps two, the river would clear its own channel and keep it clear. Mr. Coste expresses the opinion that the construction of this jetty is premature, and thinks the best results would be obtained by a commission of three experts, for the task is too big to leave to one man

Winnipeg, Man.—The fire commissioner states that 100 fires during the past year in Winnipeg were due to defective chimneys, the fault of knowingly careless workmen or contractors. His contention in one case was supported by the city building inspector, who said that a new house which was almost destroyed by fire had no mortar in the layers of bricks in the chimney against the woodwork.

Welland, Ont.—The ratepayers decided to adopt the hydro-electric by-law by a majority of. 334. The settling basin measure was defeated.

Winnipeg, Man.—The committee of the Board of Trade investigating the municipal telephone rates have started their task. The investigation will cover a wide area, and, will cover the whole management of the telephone system since it was taken over by the Manitoba Government. The question of telephones is causing considerable trouble throughout the province, owing partly to the recent deficit in the operation of the system.

The following is a list of Ontario municipalities which voted for the hydro-electric by-laws:—

Municipality—	Majority for
Ailsa Craig	85
Blyth	52
Brampton	140
Brussels	Large
Caledonia	180
Clinton	109
Cornwall	Large
Exeter	Large
Goderich	Large
Hagersville	Large
Hastings	71
Hensall	88
Kincardine	286
Kingston	Large
Lakefield	201
Listowel	Large
Lucan	Large
Owen Sound	Large
Paisley	Large
Paris	Large
Peterboro'	1,315
Prescott	154
Richmond Hill	118
Southampton	186
Tillsonburg	Large
Thornbury	140
Wingham	Very large
Wroxeter	Very large

The receivership for Allis-Chalmers Company, Milwaukee, U.S., will be of a friendly character and is one of the preliminary steps necessary in the reorganization of the company. Meantime the shops at Milwaukee, Chicago, and Cincinnati are running as usual and the operations of the company will not be curtailed. It is understood that $5,000,000 new capital has been provided. This will place that company in a far stronger position than it ever was before, and will enable it to take advantage of the revival of business which is anticipated in the United States at an early date. Allis-Chalmers-Bullock, Limited, of Montreal, is an entirely separate and distinct corporation, and is not in any way affected by the proceedings in connection with the American company. It has not felt adverse conditions similar to those in the United States; but, on the contrary, the shops are full of work and running regular time. The present proceedings will not affect the operations of the Canadian company.

TRADE ENQUIRIES.

The following were among the enquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ended December 18th, 1911:—

A Swiss firm is desirous of appointing Canadian agents for the sale of pipe-straw hats.

A London firm desire to get into touch with Canadian importers of dressed bath stone.

A firm of brokers and sales agents at Lucknow, India, are open to act for Canadian manufacturers of fancy goods, stationery, leather goods, sugar, provisions, piece goods, etc.

A Toronto firm stated to have a large staff of salesmen are desirous of taking up United Kingdom agencies.

The Canadian agent of an English manufacturer of condiments and essences is desirous of securing the agency for another line which he could work in conjunction.

A Montreal importer desires to obtain the representation of a United Kingdom manufacturer of fancy goods.

A Montreal firm of mechanical engineers stated to have a large connection wish to represent English manufacturers of railway contractors' and general engineering supplies.

A Nova Scotia correspondent desires to interest English financiers in an undeveloped coal area in that province.

A Vancouver firm of stationers, printers and bookbinders would like to get into touch with manufacturers in Great Britain of corduroy and canvas suitable for bookbinding. Samples and quotations required.

A Montreal correspondent enquires for names of miners of China clay in Cornwall.

A correspondent in Canada is desirous of finding a market in Great Britain for slaughter-house offal.

A Vancouver firm are in the market for Irish linen table cloths and similar goods. Quotations required f.o.b. Vancouver and Cape Horn or Tehauntepec.

From the branch for City Trade Enquiries, 73 Basinghall Street, E.C.:—

An Italian importing firm invite quotations from Canadian shippers of hog and beef casings.

A London firm ask to be placed in communication with Canadian manufacturers of wood pulp who are in a position to fill orders for regular shipment.

A North of England company manufacturing a patented safety valve wish to get into touch with some Canadian resident firm possessing an established connection with railways, etc., who would act as their representative.

A manufacturers' agent in Toronto wishes to secure the representation of United Kingdom manufacturers of druggists' sundries, food specialties (such as jams, custards, etc., not already represented) and novelties in photographic lines.

A Toronto manufacturing company ask to be placed in correspondence with United Kingdom producers of picker cuttings from hide stock as used in the manufacture of glue.

An engineering firm in Ottawa desire the addresses of British manufacturers of oil burners for steam boilers.

A Winnipeg firm wish to be placed in communication with manufacturers of linen-lined paper bags for sending sample seeds through the post.

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Magnet Sheet Packing

Made of the celebrated Magnet compound, this packing is totally *unaffected by heat, oil, liquor (ammonia), alkali, or by expansion or contraction.*

It is suitable for high or low pressure uses, particularly high, because of its heat-resisting properties. It neither becomes hard nor brittle. Retains its tough, elastic efficiency for months.

Magnet Sheet Packing won't *blow out.* It makes a tight joint that stays tight under air, hot or cold water or strain pressure.

Meets every requirement.

No engine room, locomotive, steamboat or machine shop is properly equipped without a roll of this great emergency packing.

GOODYEAR

Magnet High-Pressure Gasket Tubing

Made also from the celebrated Magnet compound. Forms a tight joint no matter how rough the surface may be—and it is

Pressure-Proof

Magnet Gasket Tubing can't blow out. Like Magnet Sheeting, it successfully resists any degree of steam heat and it maintains its elasticity.

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One of the big advantages of Magnet Gasket Tubing is that it may be cut any length to fit any size manhole or handhole, plate or pipe flange. Cut ends joined together with rubber core, making *continuous gasket.* Put up in convenient boxes with rubber core and tape.

If you need sheet packing or gasket tubing, grasp this opportunity. The Goodyear trade-mark stands for reduced first cost and economy all along the line. It stands for the same quality workmanship that underlies the success of the Goodyear Tire & Rubber Company, Akron, Ohio, one of the best known and most experienced manufacturers of rubber goods in the world.

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PUBLIC UTILITY COMPANIES IN BRITISH COLUMBIA.

The British Columbia Electric Railway Company operates in Vancouver and New Westminster, with suburban and interurban lines on the lower mainland. It owns the light and gas franchises in Vancouver and the lighting franchise in New Westminster, also in Victoria, where it has the lighting franchise. It has a power plant on the mainland, another near Victoria, on Vancouver Island, and is the biggest company in the West.

The British Columbia Telephone Company's charter enables it to have systems throughout the province, but its main operations are in Vancouver, Victoria, New Westminster and between these points.

The telephone company has had its own troubles to give an adequate service in Vancouver, which has grown so rapidly. There have been complaints regarding service, and suburban districts have complained also of the rates. There is a suggestion to have the provincial government take over the telephone system. The latest public body to recommend this is the combined board of trade of Richmond and Point Grey. The statement was made at the meeting that while the rates might be about the same, the service would be better. The telephone company has had to increase its rates for business telephones in Vancouver and Victoria, and this will bring further criticism.

The difficulties that beset the telephone company are infinitesimal compared with those of the British Columbia Electric Railway Company. The Point Grey by-law, giving the company power to operate in Point Grey, has been dismissed in the courts, and all construction and service has been discontinued in that suburb of Vancouver. The company has stood strictly upon its rights, and naturally will have nothing to do with any compromise proposals.

The City Council unanimously agreed to see if the company's franchise in Nanaimo cannot be cancelled, because of the persistent ignoring of requests for a better service. Certain it is that in many points which tend to the comfort and convenience of the people, the company has been deficient. In some cases passengers have to wait fifteen minutes for connecting cars. After the action of the city this week, to seek annulment of the franchise, the company, which by the use of passes keeps criticism out of the papers, gave figures to show that the number of cars used were as large in proportion as on street railway systems in other cities. It based its calculations on the population of Vancouver proper, allowing so many cars to these people. The real facts are that 30,000 to 40,000 more people are served, and Vancouver proper cannot be considered by itself, for all the people in the districts immediately adjoining work in the city and come and go morning and evening.

It is reasonable to suppose that because conditions are such that the company cannot adequately cope at present with the situation, the government will not allow cancellation of the franchise. The company has at least been sincere in its general attempts, and if it has been overwhelmed by circumstances, the fault is not altogether its own. All these inconveniences are incidents of sudden and enormous growth in the city.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

CIRCULAR NO. 73.

FENDERS OR WHEEL GUARDS.

The Board of Railway Commissioners ask that all electric railways subject to the Board's jurisdiction file, within sixty days from the date of this circular, plans showing the system of fenders or wheel guards in use on their equipment.

15595—December 12—Authorizing Government of Province of Saskatchewan to construct highway over C.P.R. in S.W. ¼ of Sec. 30, Twp. 15, R. 13, west 3rd Meridian.

15596—December 9—Suspending Wabash Railroad Co.'s Tariff 686, re "Baggage of Excess Size," until parties can be heard.

15597—December 12—Approving location of C.P.R. station at Lydiatt, Man.

15598-99—December 12—Approving revised location of Dominion Atlantic Ry. (under C.P.R. lease) from west side of St. George St., Annapolis, N.S., to west side of Allen's Creek, a distance of 2,790.5 feet, and authorizing reconstruction of Allen Creek bridge.

15600—December 14—Approving plans of C.N.O. Ry. for undercrossing of C.P.R. at Smith's Falls.

15601—December 14—Authorizing Esquimalt & Nanaimo Railway to cross with its Cowichan Lake Branch two highways in British Columbia.

15602—December 13—Authorizing C.N. Pacific Ry. to use crossing of C.P.R. Mission Branch for construction purposes only until 29th February, 1912, pending installation of interlocking plant.

15603—December 18—Approving revised location of C.N.O. Rly. (Montreal-Port Arthur) through Twps. of Bristol, Clarendon and Litchfield, in County of Pontiac, Que., mileage 162 to 176, from Montreal.

15604—December 19—Directing C.N.O. Ry. to install improved type of electric bell at crossing near Brighton, Ontario.

15605—December 16—Authorizing C.N.O. Ry. to construct bridge over Blende River, at mileage 23.96, east of Port Arthur, Ont.

15606-07—December 18—15608—December 19—Authorizing C.N.R. to cross with its Maryfield Line public road between Secs. 12 and 11, Twp. 5, R. 8, west 2nd Meridian, and with its Swift Current Line 7 highways in Saskatchewan, and with its Swift Current Line three highways in Saskatchewan.

15609—December 15—Approving location of Alberta Central Railway Co. from a point on its main line 135.58 miles west of Red Deer to Big Horn Range Coal Fields, mileage 0 to 28.

15610—December 19—Authorizing G.T.P. Ry. to cross highway at mileage 197.2, Range 6, Cassiar District, British Columbia.

15611—December 18—Approving plans of G.T.R. for station at Stevensville, 19th District, Southern Division.

15612—December 19—Authorizing C.P.R. to open for carriage of traffic its Swift Current to Brooks Branch from mileage 0 to 33.

15613—December 19—Authorizing C.P.R. to operate until June 30, 1912, its Manitou Lake Branch from a point on its Pheasant Hills Branch, being from mileage 0 to 27.8, between Wilkie and Cut Knife, Saskatchewan.

15614—December 16—Approving revised location of C.P.R. Lauder Extension between mileage 32.28 and 54.63, Saskatchewan.

15615—December 16—Authorizing C.P.R. to cross with its Wilkie Northwesterly Branch (formerly known as Manitou Lake Branch), 14 highways between mileage 13.90 and 25.78, Saskatchewan.

15616—December 18—Authorizing C.N.R. to cross with its Maryfield Line 16 highways in Saskatchewan.

15617—December 13—Approving overhead clearances of West Canadian Collieries, Ltd., for siding of C.P.R. at Bellevue, Alta.

15618—December 20—Approving location of C.N.R. Crosse Isle Extension, mileage 4.33 to 25.68, west P.M., Manitoba.

15619—December 19—Authorizing G.T.P. Ry. to cross highway at mileage 204.5, Range 6, Cassiar Dist., British Columbia.

15620—December 19—Authorizing G.T.R. to construct spur for joint use with C.N.O. Ry. on Don Esplanade, Toronto, Ont.

15621—December 12—Authorizing C.N.R. to construct spur line to Hospital for Insane at North Battleford, Saskatchewan.

15622—December 13—Authorizing Dominion Atlantic Ry. to construct spur from a point on its Cornwallis Valley Branch to Government wharf, at Canning, N.S.

15623—December 15—15624—December 13—15625—December 9—Authorizing C.P.R. to construct spurs for Alberta Consolidated Coal Co., Ltd., near Elcan Ballast Pit, Alta., and for Messrs. Anderson & Rosenroll at mileage 59.2, on Wetaskiwin Subdivision, near Ohaton, Alta., and for Messrs. Wiens & Reimer at Foam Lake, Saskatchewan.

15626—December 14—Authorizing Esquimalt & Nanaimo Railway to construct spur on Vancouver Island, at mileage 47.5 (from Victoria) to near village of Croftonat, mileage 0.78 in Chemainus District, British Columbia.

15627—December 18—Recommending to the Governor-in-Council for sanction lease by C.P.R., or Alberta Railway & Irrigation Co.

15628—December 15—Approving location of Alberta Central Ry. from mileage 100 to 140, west of Red Deer, Alberta.

15629—December 20—Authorizing G.T.P. Ry. to operate trains over overhead crossing of C.N.R., in Sec. 14, Twp. 53, R. 24, W. 4 M.

15630—December 12—Extending until February 1st, 1912, time for installation of power brakes by C.P.R. on electric cars.

15631—December 18—15632—December 15—Authorizing C.P.R. to construct spur for A. E. Burns, near Henry Avenue, city of Winnipeg, Manitoba, and spur for Rock Springs Sootless Coal Co., Ltd., near Elcan Ballast Pit Spur, Alberta.

15634—December 20—Approving location of Esquimalt & Nanaimo Ry. from Black Creek to near Duncan's Bay, on Vancouver Island.

15635—November 21—Directing that Supplement to Canadian Classification No. 15, be issued reducing carload rating of Macaroni, Spaghetti and Vermicelli, from 4th to 5th class to become effective not later than January 15th, 1912. Application Transportation Bureau of Montreal Board of Trade, on behalf of the Montreal Wholesale Grocers' Guild.

15633—December 16—Authorizing C.N.O. Ry. to use for construction purposes only crossing of C.P.R. at Chaudiere Jct., near Ottawa, until June 1st, 1912, pending completion interlocker.

15636-37—December 13—Directing that Wabash Railroad (G.T.R.) install gates at Manitoba Street, St. Thomas, Ontario, before 1st May, 1912, 20 per cent. from Railway Grade Crossing Fund, also G.T.R. to install electric bell at St. George St., Chatham, Ont., before 1st February, 1912, 20 per cent. from Railway Grade Crossing Fund.

15638—December 16—Extending until June 1st, 1912, time for installation of interlocking plant at crossing by C.N.O. Ry., of C.P.R. and G.T.R. near Ottawa, Ontario.

Have You a Want ?

If you have a position vacant, or if you want a position, an advertisement in The Canadian Engineer will do the trick. Two cents per word.

Volume 22. Toronto, January 11, 1912

Contents of this issue on page 141

The Canadian Engineer

An Engineering Weekly

THE ULTRA-VIOLET RAYS.

The engineering profession at large, and persons who have had no occasion to investigate the subject, appear to regard the rays of light as the only manifestation of the disturbance in the ether which causes the human eye to perceive and distinguish colors; this is not correct, as of late many other varieties of "rays" have been isolated and found to possess qualities vastly different from light rays. Among the latter to be isolated and examined are the ultra violet rays which have their sphere of motion at the extreme violet end of the spectrum.

The rays which are commonly called "light" are composite, being formed of seven rays which move with a sufficient relaxation to affect the optic nerves; these seven are red, orange, yellow, green, blue, indigo and violet.

The first important manifestation of these auxiliary rays were noticed by Professor Roentgen. This gentleman, not understanding their characteristics, gave them the now familiar name of X rays. As is well known, the feature of these rays which causes them to be so useful, is that of piercing many substances opaque to ordinary light rays. The X ray, however, moves at such an astounding speed as to be entirely unnoticed by the optic nerves, and in order to retard this enormous speed a screen of basium platinocyanide is placed between the object pierced and the human eye. These rays, in common with ordinary light, cast well defined shadows.

Prof. Roentgen, in his original memoir on "A New Kind of Rays," remarks that a kind of relationship between the X rays and light rays appears to exist; at least the formation of shadows, florescence, and the production of chemical action point in this direction. It has been known for some years that, in addition to the transverse vibrations which account for the phenomena of light, it appears that longitudinal vibrations may exist in the ether, and, according to the view of certain physicists, must exist. It is granted that their existence has not yet been made clear, and their properties are not experimentally demonstrated. It is a question if the new rays should not be ascribed to longitudinal waves in the ether.

The next discovery of importance in this direction was made by the Curies when they reached the source of certain radiations in discovering and isolating radium. Although these persons are justly credited with discovering and isolating the salts of radium, they cannot be credited with the prior discovery of the radiations. This honor must go to Prof. Henri Becquerel, who was following up the work of Prof. Roentgen when he became aware, accidentally, that certain inorganic substances, supposedly uranium, were capable of evolving emanations which conducted themselves in a degree, similar to the X rays. Subsequent investigation by Prof. and Madame Curie disclosed the fact that these emanations proceeded from certain impurities previously unknown, which were regarded as a residue in the distillation processes to which the uranium and salts of that element were subjected. These impurities were later found to be three undiscovered elements, and were given the name of polonium, actinium, and radium. Of these radium is by far the most active.

Professor and Madame Curie have determined the atomic weight of radium and find it to be 225. Radium, although considered an element, has not, up to recently, been isolated in the elementary condition; all experiments are carried out with the chloride or bromide.

The radiations from radium appear to possess the property of disintegrating organic tissue. A small quantity of radium introduced beneath the skin of a mouse near the spinal column, produced speedy death from paralysis. However, although this action is known, it is safe to say that no definite concise understanding of the destructive or medicinial properties of this element have been acquired.

Fig. 1.

Through the development of the mercury vapor lamp it was found possible to produce ultra-violet rays in such a form that they could be experimented with. The lamp which is generally used in a modification of the Copper Hewitt lamp illustrated in Fig. 1. In this apparatus a small quantity of mercury is confined in a glass tube, which is exhausted of air to a considerable extent. Metal electrodes protrude at the extremities, and when the current is led to the lamp the tube is tilted, allowing the mercury to strike an arc, the heat and flash which follows vaporizes the mercury or a portion of it. From the mercury in the vaporous condition come the ultra violet rays, so deadly to bacteriological and low forms of organic life.

The light is deficient in the longer wave lengths, or red. The lack of the longer wave lengths results in an unpleasant distortion of color. The ordinary glass tube allows the blue and violet rays to pass, but is entirely absorbent of the extreme violet (ultra violet) rays. To bring these rays outside, the tube must be constructed of quartz.

To construct a piece of physical apparatus of fused quartz is an extremely difficult operation, owing primarily to the enormous heat necessary—2,000° C. (3630° F.)—and the difficulty of procuring a substance that will manufacture into a suitable crucible.

Quartz is found in nature in the crystalline and amorphous conditions, the former variety being known as rock crystal and quartz sand, and the latter is found as opals and other precious stones. On a piece of rock crystal being heated in an open flame it cracks, and when the fragments are melted in the electric furnace a compact amorphous mass is produced which is absolutely insensitive to temperature influences and shows other properties entirely different from rock crystal.

In 1903 Dr. J. Frank Bottomley commenced in a small experimental works erected at Wallsend, near Newcastle-on-Tyne, Scotland, a series of investigations with the object of developing a method suitable for the manufacture of large size silica apparatus. In spite of the many difficulties encountered in this connection, the experiments after three years were sufficiently advanced to commence working on a commercial basis.

KROMAYER LAMP WITH QUARTZ EXTENSION

A ROENTGEN TUBE

QUARTZ BLOCKS AND TUBES FOR APPLYING ULTRAVIOLET RAYS, WITH PRESSURE, TO VARIOUS PARTS OF THE BODY

As it was intended to obtain a relatively cheap product, a raw material less expensive than rock crystal had to be looked for, and a very pure form of silver sand containing over 99½ per cent. of silica was used.

Electric arcs as well as various forms of resistance furnaces were used in connection with these experiments, but the arc method was found not to be practical on account of the difficulty of regulating the temperature, and the risk of the material being contaminated by fragments expelled from the electrodes. Far more satisfactory results were obtained with resistance furnaces using carbon or graphite as resistance material.

Another difficulty is due to the silica volatizing readily at temperatures a little above the melting point. The difficulty of finding a material sufficiently refractory to serve as the containing vessel, while being chemically inactive in regard to silica, was overcome by allowing the sand itself to form its own containing vessel, which method shows the additional advantage of providing an excellent heat insulating material for the lagging of the furnace. As the surface of the silica farthest from the heating resistance is not thoroughly fused, it should be subjected wherever necessary to a subsequent glazing process. As silica, even at very high temperatures, never becomes really fluid, but attains a consistency like that of tar, it cannot be made transparent. However, in this plastic condition the material is capable of being worked into shape either by blowing or by mechanical pressure. It is, for instance, quite possible to draw a length 60 feet or more of ¾-inch tubing. At the works of the Thermal Syndicate, Wallsend, where the Bottomley process is used, fusions of over 70 pounds can be made, and worked into shape, and it is hoped to increase this considerably.

The most valuable feature of these goods is their remarkable insensitiveness to temperature changes, which even allows iron ore platinum to be sealed into quartz crucibles without the latter losing their shape, their transparency to the ultra violet rays, and their insulating properties, which, though decreasing somewhat with rising temperatures, is even at the temperature of electrical furnaces quite sufficient to make the quartz an electric insulator. This feature is the more welcome, as most oxides used in industry will become conductive to electricity at high temperatures. Quartz is therefore an extremely suitable material for making electric radiators. As quartz tubes are fairly pervious to heat rays, they can, in fact, be used also for the transmission of heat. For a similar reason quartz plates are extremely practical as refractory protective mantles, undergoing a relatively immaterial heating even on being radiated upon intensely.

It would be a difficult task to name the discoverer of the ultra violet rays, but should one be inclined to search out the names of the responsible parties, certain it is that the name of Prof. Niels R. Finsen, of Copenhagen, Denmark, would occupy a prominent position on the list; in fact to that gentleman must go the honor of the pioneer work in the treatment of disease by photo-therapeutics. Prof. Finsen proved that the therapeutic properties of light in the treatment of bacterial diseases of the skin, especially lupus vulgaris, or tuberculosis of the skin, was due chiefly to two properties of the light employed, the violet and ultra violet rays; also their power to penetrate the skin and their destructive action on bacteria.

In Finsen's apparatus, the radiation from an arc lamp was filtered through water, (pure water is a conductor of the ultra violet rays) which absorbs most of the ultra red, or "heat," rays, and was concentrated upon the skin by lenses of quartz (which does not, like glass, absorb much of the ultra violet radiation, and which aids in absorbing the ultra red rays). The Finsen lamp, for the use of physicians in private practice, consists of a 20-ampere direct-current arc lamp, a "concentrator" and a "compressor." The apparatus is so mounted on an iron stand that it can be turned in any direction. The concentrator is a wide metal tube, containing a number of quartz lenses, through which a current of

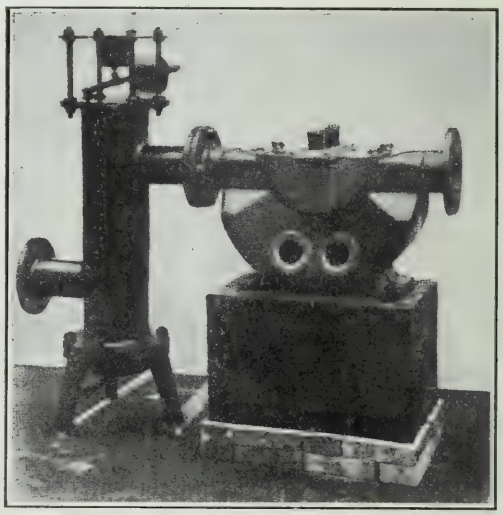

Fig. 2

cold water flows continuously. The compressor is attached to the end of the concentrator and consists of a short brass cylinder, closed at each end with a plate of quartz and filled with the circulating cold water. The terminal quartz plate is pressed against the diseased portion of the skin, which is cooled by the stream of cold water so thoroughly that a very concentrated beam of light, possessing great heating power, can be employed without danger. A still more important function of the compressor is to drive the blood from the skin and thus to make the skin more permeable by the rays. The treatment is applied for at least 45 minutes at a time. The management of the apparatus is not easy, but the method provides a sure cure for lupus and leaves no visible scars. In Copenhagen a great institution, the Finsen Institute, has been established, which receives from the Danish government an annual subsidy of 25,000 crowns (about

$6,700) in return for the free treatment of poor lupus patients.

Within the last few years many arc lamps with metallic electrodes have been invented, which emit a far larger proportion of violet and ultra violet rays than the ordinary carbon arc lamp produces, chief among which is the mercury vapor lamp.

The Kromayer lamp, which is a modification of the Couper-Hewitt lamp and finds considerable employment in light treatment of disease, contains a tube of fused quartz, two-thirds of an inch in diameter, having the form of an inverted V. The air is completely removed from the tube, the ends of which form mercury cups, which constitute the electrodes and are connected to the lighting wires. This luminous tube is inclosed in a globe, which is also made of fused quartz, and the globe is inclosed in a water-tight case of nickled brass, provided with a quartz window, which can be pressed directly against the skin of the patient. The

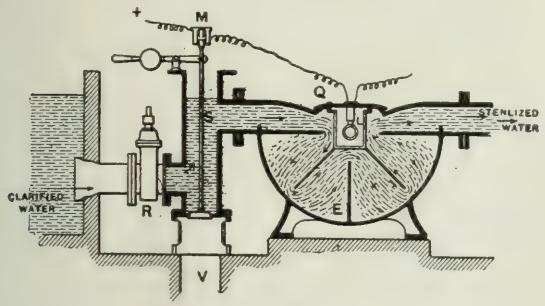

Fig. 3.

space between the quartz globe and its metal case is filled with cold water, which enters continuously through a tube at the bottom of the case and flows out through a tube at the top. The lamp is ignited by tipping it and thus causing a thin stream of mercury to flow along the tube and establish connection between the electrodes. When the lamp is righted and the thread of mercury is broken a powerful luminous arc is formed in the mercury vapor which fills the tube. Local treatment, with or without pressure, can be applied very conveniently with this lamp, but great care must be taken to avoid burning the skin. This treatment is efficacious in all forms of eczema, carbuncles and ulcers of the legs and various parts of the skin and mucous membranes, but especially in "wet" eczema and in circular baldness. Treatment with pressure is employed especially in lupus and burns.

When science had demonstrated her ability to cope with the diseases of men through these mystic rays, mankind in turn bethought himself of using this agency for the purification of his water supplies. The first serious attempt at this appears to have taken place at Marsailles, France. A description of the apparatus used and some details were given in the pages of this journal in the issue of July 13th, 1911, page 47. However, some further details will be of interest at present.

In order to find the best solution of the problem, the municipal council of Marsailles organized a concourse of sterilizing apparatus. Such a plant was required to deliver 200 cubic metres (261.5 cubic yards) of water per 24 hours, and was to be run continuously for one month. The inspection committee included some of the leading specialists in hygiene, mining and civil engineers, and professors of universities. The results of the tests showed that the ultra-violet-ray process was undoubtedly the best for municipal use, as it has none of the defects mentioned below. It uses a small amount of current, and this has now been lowered in the new apparatus. Neither taste nor smell is given to the water, and the sterilizing is very effective. At the same time the process is easy to carry out and the apparatus needs but little attention. The first cost of the plant is low, and it occupies but a small space.

There seems to be a great future in store for the new method, seeing that it has none of the drawbacks which are found with the other processes when it comes to using it on a large scale.

In the sand-filtering method, for instance, the filters occupy a large surface of the plant, and when not properly operated the results are very imperfect. Besides, the first cost of installing the filtering plant is high. Chemical products added to the water for sterilizing have the disadvantage of giving a bad taste to the water, and the method is not much favored for that reason. One of the best methods, to recent date, for municipal plants has been the ozone process, it has been used in some large cities. However, it gives a certain taste to the water which disappears but slowly, and on the other hand there must be a great care taken in the ozone production in order to avoid forming any nitrogenous products, which would vitiate the water. Hence the process is somewhat difficult to carry out, or at least needs great care and attention.

The ultra violet ray apparatus was used in connection with a Puech-Chabal filter in order to act upon clear water, and this was necessary from the fact that the Duvance water is very heavily charged with impurities which render it turbid. After leaving the filter it passes at a continuous rate through the ultra violet ray apparatus.

Fig. 2 shows the appearance of the Marseilles apparatus and Fig. 3 the sectional view. In the former apparatus, the lamps were placed above the surface of the water upon floats, so that all of the radiation from the lamp could not be used, and in fact there was only one-third of the rays actually employed for the sterilizing. A means was sought of utilizing greater proportion of the rays without changing the manner of working the arc. Ii is recognized that the working of the lamp depends essentially upon the temperature of the electrodes and the luminous tube, so that if we cool the lamp too much we will not obtain the same yield in ultra violet rays as before, and to reach the same yield, the current must be considerably increased. For instance, if we immerse the quartz lamp in the water itself, according to Messrs. Courmont and Nogier's method, we are obliged to double the current in order to obtain the same yield as in air.

A great improvement is obtained by the Marseilles apparatus in this respect, as it allows of utilizing more than three-quarters of the rays given by the lamp, and here the lamp burns in air at its best conditions of working, and immersing it in the water is avoided. The lamp is placed in a rectangular case whose three sides lying parallel to the lamp tube are formed of quartz plate. The tight box Q containing the lamp L is placed in a semi-circular apparatus having five partitions in the inside. The water is taken from a tank of filtered water and passes through a gate valve and a cylinder chamber S, then entering the main tank E. It follows around the path which the arrows indicate, and in this way it is exposed for some time to the action of the ultra violet rays, so that we have a powerful sterilizing effect. It is found best in practice to use an automatic valve at the water inlet and it operates in the chamber S. A valve in the lower part of the chamber is normally closed and is held up in this position by an electro-magnet M which attracts an armature mounted on the end of the valve rod. A counterweight is used to give the proper adjustment of the weight. The electro-magnet is connected in series with the lamp, so that when current passes in the lamp circuit the magnet acts and the valve is held closed. Should the current fall or the lamp break, the magnet allows the valve to

drop, and the water now passes directly out of the apparatus by V into the sewer or elsewhere and no water will be delivered into the sterilizing chamber. Thus there is no danger of having unsterilized water flowing through the apparatus in case the current should fail. During the tests which were made at Marseilles, a quartz lamp of the Westinghouse-Cooper Hewitt type, with a current of 22 volts and 3 amperes was used, and the apparatus was run from August 19th until the end of September, working day and night without stopping. It gave an output of 60 cubic meters (78.5 cubic yards) per 24 hours, or 32¾ cubic yards per hour. During that time there were made eighteen bacteriologic tests of the incoming and outgoing water. Before entering the apparatus the (impure) water contained 30 to 300 germs per cubic centimeter (0.061 cubic inch) and 50 to 1,000 coli bacillus per liter (1.057 quarts). After sterilizing, on the average one germ per cubic centimeter and no coli bacillus in any case.

Following the foregoing synopsis of this recent art (photo therapeutics) it would be well to return to the rays themselves and consider them in more detail.

For a correct conception of the therapeutic value of these rays, it must be borne in mind that ultra violet rays are readily absorbed by most substances. Very few bodies are transparent to them. They even pass through air with difficulty, but they traverse without appreciable absorption quartz, Iceland spar, pure water and a variety of glass called Uviol, invented recently by Schott of Jena. Both the ultra violet and the visible rays are distinguished among themselves by their wave-lengths, which stand in an intimate though complex relation to their indices of refraction, or to the relative positions occupied by the different rays after refraction by a prism. The unit of measurement of wave-length is the micron, equal to 1/1,000 millimeter, or 1/25,000 inch. The Angstrom unit, equal to 1/1,000 micron, is also employed.

Up to the present the mercury vapor arc has been employed as a source for these penetrations, several forms of

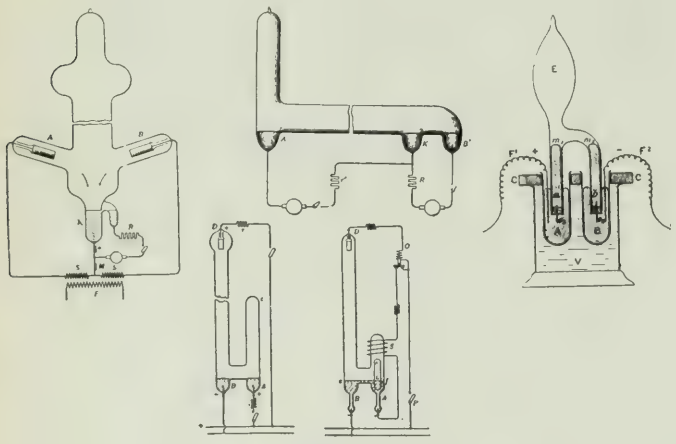

Fig. 4.

which are shown in Fig 4. All these lamps operate on the same principle, viz., metallic and carbon electrodes and a pool of mercury which is allowed to flow in a stream toward (generally the positive) electrode, thus completing the circuit and striking an arc.

The use of this lamp is attended with certain inconveniences, among which are the mechanical devices necessary to strike the arc, the high wattage and the uncertainty of maintenance. The bactericidal effect of the ray is due solely to the radiations themselves and not to any ozone or hydrogen dioxide that may be formed, for the production of an appreciable quantity of these substances requires several hours, but the sterilization is instantaneous. Bordier and Nogier and other physicists have proved that air exposed to the radiations of a quartz mercury vapor lamp acquires an odor resembling that of phosphorus, which was at first attributed to the production of ozone, but it is impossible to detect the least trace of ozone in this air, and the same odor is produced in nitrogen and other gases which contain no oxygen. In reality the odor is of physiological or subjective origin, and is due to the excitation of the olfactory nerves by the ionized and electrified air. If the gas is passed through a metal tube connected with the ground and thus deprived of its electrical charge, the odor dsappears.

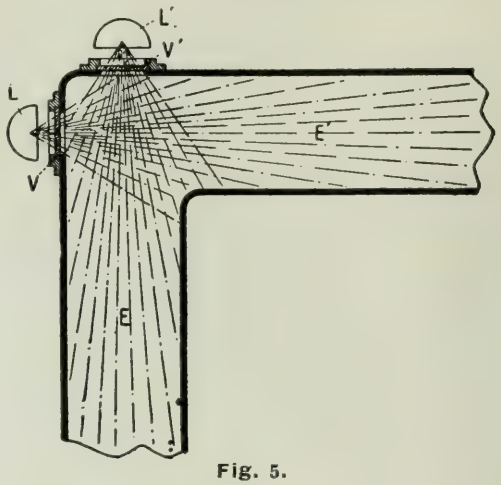

Fig. 5.

New researches by Courmont, Nogier, and Henri confirm the view that ozone and hydrogen dioxide play no part in the sterilization produced by these lamps, which is due to the direct action of the ultra violet rays. Water sterilized by this process retains its dissolved air, since it has not been heated. It remains fresh and its flavor is not changed in any way.

For municipal water service the sterilization may be effected in the water mains (Fig. 5). In order to avoid breakage of the lamps by the pressure and flow of the water they are placed outside the mains and their radiations are transmitted through windows or bull's eyes of quartz.

Some experiments are under way in the City of Toronto with the "hyper ultra violet rays." It was originally intended to generate this rays from iodine and mercury, but subsequent investigation and research showed a method of treating certain common inorganic gases with electric discharges in such a manner as to produce a volume of ultra violet rays 2,500 per cent. in excess of the mercury arc lamp. This lamp is almost devoid of luminosity under operation. Some account of the experiments and further information will be given regarding this lamp in a future issue.

SEWER SECTIONS.

Economical sewer sections have been the subject of study by Mr. Alberto Schreiner, assistant engineer in charge of design for the Bureau of Sewers, Borough of Queens, New York City. The experience in that office has led to the general conclusion that it is desirable, from the standpoint of low cost and ease of construction, to use vitrified pipe on all lines up to 24 in. in diameter. For sewers having diameters between 24 in. and 4 ft. plain concrete is believed to be the most economical type of construction but for diameters greater than 4 ft. it has been found that reinforced concrete may be used to best advantage.

HISTORY OF TAR-CONCRETE PAVEMENTS IN ONTARIO.*

By W. A. McLean, Provincial Engineer of Highways, Ontario.

Tar-concrete, or more popularly, "tar-macadam" pavements have been in service in several cities of Ontario, Canada, for a number of years, and the history of the earlier of these, while not accompanied by all desirable data, presents features of interest, in view of the growing use of bituminous materials for country highways.

Reference has, from time to time, been made in the technical press to the tar-concrete pavements of Hamilton, Ont., and it is the purpose of this paper to include also the experience of Toronto, Ont., London and other cities. In all cases the pavements have been laid by the mixing process, and coal gas tar (supposedly) was employed.

The beginning of tar-concrete roadways in Ontario was in the year 1880, when the Gas Company of Hamilton laid a short section (Mulberry Street) about 1,300 square yards, in that city. No further work of this class was done until 1891, when the same company laid 2,983 square yards at a contract price of $1.50 per yard; and in 1893 another area of 3,768 square yards was laid at a contract price of $1.75 per yard. Experience with these roadways was such that, in 1899 when a considerable extent of old cedar block pavement needed renewal, "tar macadam" was selected and about ten miles of roadway were built of that material.

Hamilton.—The following is the specification under which the later pavements (since 1899) were laid in Hamilton:—

(1) "All earth or other material above the sub-grade shall be excavated, so as to conform to the level of the sub-grade, which will be twelve inches below the finished surface of the roadway; and should the sub-grade be above the level of the natural ground, then earth shall be deposited until the level of the sub-grade is reached. The sub-grade shall be shaped to the profile and cross-section which will be furnished by the city engineer.

(2) "After the sub-grade has been formed to the proper camber of the road, generally one-half inch per foot, or six inches for a 24-foot roadway, to be thoroughly rolled with the steam roller, and if by this means soft spots are revealed, they shall be filled with good solid material.

(3) "The first six inches shall be made in the ordinary way for a macadam or telford roadway thoroughly rolled. If so required it may be made of hard broken stone, furnace clinkers, or brick rolled smooth and finished to the required camber of the road. Upon this shall be placed the tarred stone. The first layer, three inches of hand-broken stone to pass through a 2-inch ring, then a 2-inch layer of machine-broken stone, the whole smoothed off with a hand roller, and after top dressing is applied, thoroughly rolled with a steam roller. On this a layer of fine gravel and quarry clippings, mixed in equal proportions, three-quarters inch thick, shall be placed, and well rolled in so as to fill all interstices. Before finishing, a dressing of stone screenings, for the purpose of coloring, shall be scattered broadcast to be worked in by the traffic. All layers, including the coloring layer, shall be thoroughly compacted by rolling.

(4) "The stone to be tarred shall, if moist, be heated on an iron floor, under which are flues from a fire, until the moisture is driven out. The material in its heated state is then thoroughly mixed with a sufficient quantity of tar. The broken stone in warm weather may be screened, but in all cases the finer course must be artificially dried. At the same time care must be taken not to get this material too hot. The tar should be boiled in iron kettles holding one hundred imperial gallons. Eight imperial gallons should be added to each cubic yard of the coarser material or more if required to completely cover the stone, and seventeen to eighteen gallons to the finer kind of stone.

(5) "The tar must be pure coal tar free from all foreign substances, and containing not more than 5 per cent. of water, and shall contain upon analysis not less than 56 per cent. pitch.

(6) "The work must be done in the summer months, and all work must be suspended during wet weather."

The tar-concrete was used to replace cedar block pavement, and the preliminary work consisted in the removal of the old cedar blocks. As these were ten inches in depth, it was necessary to remove two inches of sand upon which they were placed, to make room for the twelve inches of macadam, and bring it to the proper elevation with respect to the curb.

The cedar blocks and surplus sand having been removed, the sub-grade was thoroughly rolled with a 15-ton steam roller.

Care was taken in forming the sub-grade, and in laying each layer of stone, to bring the surface in each case parallel to the finished crown of the roadway. The first six-inch foundation course, referred to in section 3 of the specification, was made up of flat stones, from 6 to 12 inches in greatest dimension, laid roughly by hand on their natural beds. On this, smaller stones were placed and broken into the interstices, so as to keep the bottom course in place.

The next two courses of tarred stone were then applied. Large kettles were hung close to the work, and in them the tar was kept at a workable temperature. Convenient to the kettles, the stone to be tarred was placed on mixing boards. with a dipper attached to a wooden handle, the tar was then applied to the stone, being scattered over it by a swinging motion of the dipper.

With shovels kept hot to facilitate the work, the stone was turned over twice after the first application of tar. More tar was then scattered over the stone, and the stone again turned over. These operations of tarring and turning the stone were repeated until each stone was seen to have a coating of tar, there being no bare spots on the stone. One part of tar to 22 parts of stone was specified for this course.

As soon as the stone had been tarred, it was shovelled into wheelbarrows, placed on the road to the desired depth, and raked to the required cross-section. It was found of advantage to roll the tarred stone immediately after being placed on the road, since, if left two or three days, it would not consolidate as perfectly.

The top course of fine tarred gravel was mixed in the proportion of about 20 gallons of tar to one cubic yard of gravel; or one part of tar to 8 or 9 parts of gravel. The gravel, before mixing, was screened through a ¾-inch mesh. This material was prepared in an asphalt mixer, being brought hot to the road, and carefully raked to the required grade and cross-section. This having been rolled, stone screenings from the crusher were scattered over the surface to harden it, and improve the appearance.

The cost of the various pavements varied considerably. In 1899 the average was about 79 cents a square yard, but labor then cost 15 cents an hour, and coal tar f.o.b. Hamilton $2.60 per barrel (50 U.S. gallons). The average in 1900 advanced to about 88 cents a square yard; with labor at 17 cents an hour and coal tar at $3.75 a barrel. With the

* Paper read before the American Association for the Advancement of Science.

advancing cost of labor and materials the cost in 1901 averaged nearly $1.08 per square yard exclusive of curb—about 30 cents per yard more than in 1899. Plain macadam laid in 1901 averaged 53 cents a square yard.

None of the pavements were constructed by contract, all work being done by corporation labor. The stone used was a hard limestone quarried within the city limits, the average haul to the work being 1½ miles.

Toronto. — Following the experience of Hamilton, the City of Toronto in 1900 laid an experimental tar-concrete roadway on Woolsley Street, of three blocks, or approximately, a quarter of a mile in length. This roadway did not have the heavy foundation, characteristic of the Hamilton pavements, but after the sub-grade had been carefully prepared and rolled, a course of broken limestone 4-inch in thickness, was spread. This consisted of stone not less than 1¾-inch or more than 3-inch in length or breadth. This was filled with sand, was flushed, and thoroughly rolled. On this course was spread a layer of tarred stone, which was required to be as uniform in size as possible, and not less than 1½ inches or more than 2 inches in size. This surface was evenly raked and rolled. Then a layer of ¾-inch in thickness of fine granite chips thoroughly tarred, was evenly spread over the whole surface and rolled. Before finishing, a dressing ½-inch in thickness of approved pea gravel was spread over the entire surface of the roadway, to be worked in by traffic. The specifications for mixing tar were very similar to those employed in Hamilton. Additional pavements were laid in 1901 and 1902. For two or three years, these pavements were most favorably regarded as being smooth, noiseless, sanitary and dustless, but in 1903 marked signs of disintegration began to appear, and under specifications prepared for 1904, it was then provided that there should be a foundation course 5 inches in thickness. The intermediate course of tarred stone was eliminated, and a wearing surface 3 inches in thickness was provided. Three sizes of broken stone were used in this tarred surface, viz., 1½-inch, ½-inch, and screenings. A mixture of these three sizes of stone in the proportion of two parts of 1½-inch stone, one part of ½-inch stone, and one part of screenings, was found to give a dense aggregate. During the period 1900 to 1906, there were laid in all, 7.16 miles of tar macadam roadway on the streets of Toronto.

Work carried on in 1905 required a foundation course five inches in thickness after rolling, this to be of coarsely broken stone, the surface interstices to be filled with 1½-inch stone, and covered with a layer of hot bitumen using not less than one gallon per square yard. The specification provided that:

"Upon the above foundation course is to be laid a surface course, or wearing surface thoroughly saturated with the bituminous composition. This course shall be composed of good, hard and tough limestone, samples of which must be approved by the engineer before any is delivered on the ground, and shall be equal as to quality, size and fineness to the samples which may be seen in the office of the city engineer.

"Of this mineral aggregate:

"(1) 30 per cent. shall be such as will pass a No. 40 sieve.

"(2) 12 per cent. shall be such as will be held on a No. 40 sieve and pass a number 8 sieve

"(3) 10 per cent. shall be such as shall be held on a No. 8 sieve and pass a number 4 sieve.

"(4) 18 per cent. shall be such as shall be held on a No. 4 sieve and pass a ½-inch sieve.

"(5) 30 per cent. shall be such as shall be held on a No. 12 sieve and pass a ¾-inch sieve.

"These different sizes of stone shall be heated to a temperature of at least 225 degrees Fahrenheit and not to exceed 275 degrees Fahrenheit. The No. 1, 2, 3 sizes of stone shall then be measured in accurate proportions by volume, and thoroughly mixed with a twin-pug or other mechanical mixer, the previously prepared mixture of tar and pitch shall then be added together with sizes No. 4 and 5 of the broken stone, and the whole mass mixed until the stone dust has become saturated with the mixture of tar and pitch, and is thoroughly mixed through the whole mass, and has a uniformly black appearance.

"This aggregate shall then be spread over the entire roadway to the required depth so as to produce a thickness of not less than three inches after being rolled and consolidated. The surface shall be evenly raked, rolled, repaired, brought fully up to grade and true to cross section wherever required and then rerolled until firm, compact and true.

"A flush coat of California asphalt, oxygenized asphaltum, or other equally good and suitable asphalt, in the engineer's opinion, having a melting point of about 170 degrees Fahrenheit shall be flushed over the entire surface at a temperature of at least 250 degrees Fahrenheit, so as to fill all interstices, and present a smooth, perfectly unbroken surface. A sufficient layer of good approved limestone chips, no particle of which shall be more than ½-inch in greatest dimension, shall then be spread over the whole surface and thoroughly rolled. More limestone chips shall be added where and as required from time to time, as the rolling progresses so that the whole surface is completely and evenly covered with a uniform coating of limestone dust when finished, of not less than ⅛-inch, nor more than ¼-inch in thickness after rolling has ceased.

"On commencing work a measured quantity of tar and any quantity of pitch shall be heated in separate kettles of at least 100 imperial gallons capacity. When the pitch is melted a sufficient quantity shall be added to the heated tar to make a mixture as previously determined by laboratory tests from time to time, and the whole (constantly agitated to ensure a perfectly uniform mixture) ready for use. As more is needed, measured quantities of melted pitch and tar are added in the proportions which shall be determined by laboratory test, and brought to a temperature of at least 200 degrees Fahrenheit, and not to exceed 250 degrees Fahrenheit. Reliable thermometers shall be used to determine temperatures.

"Paving pitch to have the following characteristics:— Tenacious, not relatively brittle at ordinary temperatures, insoluble in water, specific gravity of about 1.150, and have a melting point not under 200 degrees Fahrenheit.

"Tar is to be coal gas tar, should be quite thick at 70 degrees Fahrenheit, have a specific gravity of 1.200, and be entirely free from water and the lighter hydrocarbons. To ensure the above characteristics, the crude tar should be previously heated to 250 degrees Fahrenheit.

"Tar that has been refined to the desired consistency may be substituted for the mixture of tar and pitch specified. This refined tar shall have the following characteristics: Tenacious, insoluble in water, all carbonaceous matter soluble in ordinary tar menstrus, free from water and the lighter hydrocarbons. It shall have a flowing point, as determined in a dry oven, of 120 degrees Fahrenheit, and shall be similar in consistency to the standard sample which may be obtained by the manufacturer at the city engineer's office."

London.—The City of London in the year 1900 laid a tar macadam pavement on Queen's Avenue, one of the important streets of that city, of which the specification in part provided that, on the usual construction of sub-grade

should be laid a 6-inch foundation of clean coarse gravel, to conform with the cross section and finished grade of the street. Upon this foundation of gravel when thoroughly rolled was then placed 3 inches of tarred stone capable of passing through a 2½-inch ring, 20 per cent. of which being fine crushed and capable of passing through a 1½-inch ring. This crushed stone was heated on a steel platform or pans to 120 degrees, and tar composition then poured until the stone was thoroughly covered. Tar was heated to boiling point (212 F.) and pitch to about 240 degrees, and the whole thoroughly mixed. After mixing it was placed on the street and graded evenly to the required depth, then rolled with a horse roller, after which it was rolled with a steam roller. A second course 2 inches in depth of crushed stone passing through a 1½-inch and 1-inch ring respectively, mixed in the same manner, was placed and rolled with a horse roller. On this second course was then spread the finishing coat 1 inch in thickness, composed of a thorough mixture of sand, pitch and tar. The sand was thoroughly dry and heated to at least 120 degrees Fahrenheit. This coat was applied while hot, spread evenly to the proper thickness, and rolled with horse roller, after which the whole pavement was rolled with the steam roller and sanded with dry sand ½-inch in depth. Traffic was to be kept off for a period of at least one week. Tar was to be heated to 212 Fahrenheit and pitch to 240 Fahrenheit, and properly mixed in the ratio of ten gallons of tar to one gallon of pitch per cubic yard of crushed stone, and eleven gallons of tar to one of pitch per cubic yard for the top coat. Tar was required to be clear coal gas tar containing no water gas tar; the pitch also to be the best of its kind manufactured from pure coal gas tar.

Guelph.—The City of Guelph in 1908 laid one block of tar macadam. This consists of a foundation of rough stone, 8 inches in depth. On this was laid a 3-inch layer of 3-inch stone. Then followed a 3-inch layer of 2½-inch tarred stone; then a 1-inch coat of ½-inch stone tarred. Both stone and tar were heated, the hot tar being poured over the dried stone. Several other streets, aggregating 27,016 square yards have since been similarly paved. The tar is produced at the municipally-owned gas works. For both coats of stone, the amount of tar used averaged 2½ gallons per square yard.

These roadways are giving satisfaction, and show very little sign of wear. In the years 1910 and 1911 concrete foundations on tar macadam roadways were found to be cheaper than stone. In laying the surface the concrete base was flushed with hot tar. The 2-inch broken stone was then spread to a thickness of three inches, and rolled once or twice with a 15-ton roller. The stone was then sprinkled with hot tar sufficient to coat most of the stone, but not enough to fill the voids. For the surface, half-inch stone free from dust, was dried on plates and mixed on a mixing board with hot tar, then spread and rolled until well compacted.

In laying the earlier roadways the tar was boiled in ordinary tar kettles, but this method was too slow. The city now uses an old steam boiler set in brick work in the ordinary manner. The tar is emptied into the boiler from an elevated platform, and after being boiled is drawn off by a pipe from the bottom into a tank wagon, and immediately taken to the street. The only refining is by boiling. A slow fire is necessary and constant stirring to prevent boiling over. The tar is frequently tested by cooling a little in water, and the boiling is continued until the tar becomes of the desired consistency.

Ottawa.—Tar-concrete pavements were first laid in Ottawa in the year 1902, and the total length laid has been 5.15 miles. In construction, the [illegible] was graded to the required sub-grade, which was then rolled with the 15-ton roller if soft or loose, until thoroughly compacted. Upon this the spalls were placed to a depth of from 8 to 10 inches, and the top spalls broken up by hammers and made to conform to the shape of the roadway. On the spalls was placed a layer of 2-inch stone, 3 inches thick and well rolled. The next layer consisted of 2-inch tarred limestone, 3 inches thick, and put down while hot and rolled at once until cool. Great care was taken with this layer to see that it conformed to camber and grade in crown and gutter. The last coat or wearing surface consisted of a 1-inch layer of ⅝-inch tarred limestone, laid down while hot and rolled until it presented a hard, smooth surface. This surface was then dusted over with limestone dust to fill up any interstices and render it water-tight. The amount of crown on these pavements varied according to the width from 7½ inches to 8½ inches, being reduced in amount as the longitudinal grade increased.

Chatham.—One block of tar macadam was laid in 1898, but this has not been satisfactory, owing, apparently, to the surface of the tar macadam being destroyed by a coating of clay brought by the wheels of vehicles from unimproved streets. In 1910 it was sufficiently intact, however, to be used as the foundation for a bitulithic pavement.

The specifications for the tar macadam required:—An excavation 12 inches below the finished grade of the pavement; an 8-inch layer of broken stone; a 4-inch layer of tarred stone; a ¾-inch layer of fine tarred surface coating.

The stone to be tarred was spread on an iron floor, under which were flues from a fire, and heated until the moisture was driven off. The stone in its heated state was then mixed thoroughly with tar. The tar was previously boiled in an iron kettle holding 50 imperial gallons, to which was added a bucketful of pitch. Eight imperial gallons were added to each cubic yard of coarse stone, and from ten to twelve gallons to the fine stone. The cost of the tar macadam was $1.23 per square yard.

Results.—The tar-concrete roadways described, have been made from commercial tars. The work was principally by day labor under corporation foremen and engineers. Reference to proprietary tar products has been purposely avoided. The writer is not personally familiar with the first tar pavements laid, but has observed construction and results in numerous cases since the year 1900. The general history of these pavements has shown much similarity. For the first three years the surface has been all that could be desired, but about the end of that period a disintegration of the top coat has commenced. At the end of five years a mottled condition has become general, where the seal coat has chipped away, exposing the coarser bed of tarred stone. At the end of ten years the surface has become generally disintegrated, but the foundation has rarely, if ever, broken through, and a portion of the tarred surface course remains in place. Sections of the Mulberry Street pavement in Hamilton, laid in 1880, can still be seen. In no case has it been found that adequate attention has been given to the repair of these pavements by tar painting, or patching with tarred stone.

In the cities of Hamilton and Toronto, both of which have municipal asphalt plants, the tar pavements have been restored by giving a complete surface of sheet asphalt. The greater part of the tar-concrete roadways in Hamilton laid since 1899, have been treated in this way at the end of ten years, and results have been very gratifying. James Street south, in Hamilton, with central lines of car tracks, has been treated in this way, and is indicative of results under heavy traffic. Dupont Street in Toronto, constructed as a tar macadam in 1903, was surfaced with a coat of sheet asphalt one inch in thickness in 1908, and the pavement is to-day (1912)

in good condition. This was put on the tar macadam merely as a seal coat. A section taken from the pavement shows the tar to be in a plastic condition. The cost in Hamilton for the asphalt surface was 75 cents a square yard, where a binder course was required; and about 45 cents a square yard where such binder course was omitted.

Under the later Toronto specifications, in which the tarred material was proportioned for greatest density of aggregate, superior results were obtained, as for example, on Hawthorne Avenue, a street of light residential traffic. This street, paved in 1905, is now in excellent condition, and shows very little sign of surface disintegration.

The tar used was supposedly in all earlier cases, the commercial coal gas product, crudely heated to drive off water and volatile oils. In every case difficulty was found in obtaining a uniform quality, and no doubt much of the disintegration was due to the use of inferior tar. In view of the fact that in English practice a desirable tar contains not over 2 per cent. of water, or 5 per cent. of volatile oil, that it shall have at least 80 per cent. of pitch, it is apparent from the specifications quoted in this paper, that earlier Canadian construction was very indefinite in this regard and permitted the use of a quality of tar not now sanctioned.

The tar pavement in Chatham is interesting from the fact that its more rapid disintegration apparently resulted from clay being tracked on from adjacent streets, and would corroborate the experience suggested by the State Highway Engineer of Maryland, that clay would appear to have an emulsifying effect on bituminous binders.

A side-light is thrown on the use of tar by experience with foot-walks of tarred gravel. Early in the history of tar pavements, sidewalks were used, but have now been almost entirely displaced by the more durable, but less agreeable, cement concrete walks. These walks were laid by first putting down a foundation layer of gravel, which was well consolidated by pounding. On this was spread a three-inch layer of tarred gravel, well rammed, and this finally given a paint coat, and sprinkled with clean, coarse sand. The tar used is the ordinary commercial gas tar, merely heated to permit mixing with sub-dried gravel. Enough tar is used to coat each particle of gravel, about one part of tar to eight or nine parts of gravel. It is considered of primary importance to obtain a firm and unyielding foundation, and to thoroughly consolidate the tarred material. In Richmond Hill a hamlet near Toronto, these walks, for example, were first laid in 1886; the earlier and more experimental were not a success, but others laid in 1889 are still in use. These, every two or three years, are given a paint coat of tar, gritted with clean, sharp sand. Made of gravel, there is a tendency for the crown to flatten not apparent in pavements of crushed stone.

Owing largely to the reduced price of asphalt, the use of tar (other than proprietary forms of construction) has been discontinued in Hamilton and Toronto, these having municipal asphalt plants. Ottawa has stopped the use of tar for this reason, and also because of the uncertain results which have attended its use there. The city of Guelph, having a municipal gas plant, continued the construction of tar concrete roadways, using some care, however, in refining the tar to remove water and volatile oils.

Were exact data available as to the quality of material used, and variations from the prescribed specifications, numerous positive conclusions might be deduced from the tar concrete work described. Under the circumstances, while reasonably positive in certain particulars, other factors are merely suggested. It may, the writer believes, be concluded that tar of uniform quality, and of composition within certain range of proportions, while susceptible to extremes of temperature, becoming brittle and slippery in cold weather, and soft under midsummer extremes of heat, is not debarred by climatic or other conditions, as a useful road material; that best results require a dense mixture, preferably proportioning the aggregate for maximum density, in order that internal deterioration will not occur from moisture or atmospheric action; that some doubt may be attached to the complete durability of bituminous surfaces made by the penetration process, in which density of aggregate is lacking, and suggesting that the grading of stone in this method, rather than having a uniform size, is desirable; that a moderately coarse aggregate should be brought to the surface, as far as practicable, to overcome slipperiness and take up wear; that tar-concrete is less durable under concentrated wear than is sheet asphalt, wearing rapidly when laid along street car tracks where traffic is confined to narrow lines, but is more resistant to moisture as indicated by the greater durability of tar in gutters; that broken stone will provide a more stable structure than will water rounded gravel when bonded by tar; that a paint and grit coat is necessary as a preservative as frequently as signs of surface wear or oxidation appear; and it is probable that such treatment will add to the durability of any bituminous pavement, restoring necessary oil, and not merely repairing the worn surface but gradually increasing its thickness.

MINE ACCIDENTS IN CANADA.

Statistics recently compiled by the Commission of Conservation show that the death rate in Canadian coal mines is much higher than in any other civilized country. In 1902, the year of the Fernie disaster, the death rate per 100 men employed (above and below ground), reached the maximum rate of 13.25. The average rate for the ten years preceding 1910, however, was 4.79. The United States comes next with an average rate for the same period of 3.43. Perhaps the worst aspect of the situation is the fact that the death rate from coal mine accidents has been steadily on the increase in Canada for a number of years. The minimum rate of 1.83 was reached in 1897. In 1909 the rate was 4.21. During the same time there has been a steady decrease in all the leading European countries.

It would, of course, be unreasonable to expect that the loss of life and property could be entirely done away with, but experience has shown that careful investigation of the conditions will point the way to the remedying of many abuses. That the danger inherent in coal mining can be largely eliminated is shown by the low, constant death rates in Belgium and Great Britain. Coal mine explosions are much more frequent in Canada and the United States than in any of the European countries. The following example is exceedingly significant. In 1850 the fatality rate in the Belgian coal mines was as high as the present Canadian death rate, while at the present time it averages the lowest in the world. This decline in the death rate was due to the combined efforts of the mine owners, the workmen and the Administration of Mines. to the diffusion of technical and professional knowledge and to the administrative organization for the scientific study of accidents.

Although the death rate in metalliferous mines in Canada is lower than in the coal mines, it is much higher than in any of the European countries. The death rate in Canada for the period 1900-1909 was 3.82.

With the exception of the Kimberley diamond mines and the Transvaal, where native and Chinese labor are employed, the fatality rate during this period (1900-1909) was considerably lower elsewhere than in Canada. It requires no discussion to emphasize the importance of an inquiry into the whole subject of fatal accidents in the mines of Canada.

WORK OF CANADA'S CONSERVATION COMMISSION.

BY HON. CLIFFORD SIFTON.

During the two years that the Commission of Conservation has been in existence Canada has made substantial progress in the work of conserving her natural resources. That this is so is due largely to the effective co-operation of the general public and of the Dominion and Provincial governments. The Commission is merely an advisory body, and its success, therefore, depends upon the support given it by public opinion and by the various governments adopting its recommendations. The fact that the Dominion and Provincial ministers who administer natural resources are ex-officio members establishes a connection that conduces very largely to effective work.

What has been done in the way of actual accomplishment since the inception of the Commission may best be presented under the head of the different resources. The initial work consists largely in discovering what we have, and in ascertaining the efficiency of our present methods of development. This is particularly applicable to lands. To ascertain the state of agriculture, the committee on lands of the Commission has, with the assistance of the agricultural colleges and the deputy ministers of agriculture of the various provinces, for the past two years conducted a survey of one hundred representative farms in each province. The investigation disclosed the fact that only about nine per cent. of the farmers of Canada followed any effective and intelligent system of crop rotation. After fully considering the data obtained, it was estimated that the quantity of field crops in Canada could be doubled in twenty years by the adoption of such measures as may now be easily taken.

The committee on lands is also conducting experiments with alfalfa in Quebec to find out in what districts and under what conditions this crop can be most profitably cultivated. The experimental plots are located on farms throughout the province, and the operations are being supervised by Prof. L. S. Klinck, of Macdonald College. The plots, in addition to being used for experimental purposes, will also illustrate to the surrounding farmers the best way to grow this important crop.

In regard to forestry, attention has been concentrated upon the prevention of forest fires. Investigations conducted in the field by skilled woodsmen showed in 1910 that about thirty-four per cent. of all forest fires for which causes could be assigned were due to railway locomotives. The Commission, therefore, recommended to the Dominion Government that legislation be passed penalizing railways for fires set by them. A conference of the Minister of Railways, the chairman of the Railway Commission and myself was held, and, in the last Parliament, Hon. G. P. Graham had an amendment to the Railway Act passed empowering the Railway Commission to compel the railways to maintain an efficient and properly equipped fire patrol. The law now provides also that railway companies shall be liable for damages caused by sparks from their locomotives, whether it was shown they were guilty of negligence or not, said liability for damages not to exceed $5,000 if modern and efficient fire-preventing appliances were used.

A further recommendation of the Commission was that the eastern slope of the Rocky Mountains be set aside as a permanent forest and game reserve. This reservation was made by an Act of the last Parliament introduced by the Hon. Frank Oliver, former minister of the interior. An area exceeding 14,000 square miles in this part of Canada is thus reserved, constituting an important regulating influence for the water supply of the Prairie Provinces, a great forest reserve, and the largest national park in the world.

The province of Ontario is in the front rank in regard to the setting aside of forest reserves. Under the administration of the Hon. Frank Cochrane, late minister of lands, forests and mines in the Ontario government, certain lumbering rights, both within and without the boundaries of the Algonquin National Park, were extinguished and the park considerably enlarged. The question of still further extending the boundaries of the park is now receiving the attention of the Provincial Government.

New Brunswick last year also made a forward step in its forest policy. Largely through the efforts of the surveyor-general, Hon. W. C. H. Grimmer, the provincial legislature adopted the policy of prohibiting the export in its raw state of pulp-wood cut from Crown lands. There are now four provinces—Ontario, British Columbia, Quebec and New Brunswick—that have stimulated the pulp industry by such measures.

The work done by the Commission of Conservation in connection with mineral resources is summarized in a report issued in 1911. This includes a digest of the mining laws of Canada and an article by W. J. Dick, mining engineeer to the Commission, giving the known extent of our mineral resources, and indicating how waste can be further eliminated in their development. Mine accidents, in which Canada does not hold an enviable record, are also treated in some detail. During the past summer Mr. Dick investigated mining methods in the coal mines of British Columba and the West. The results of this work will be published later.

HON. CLIFFORD SIFTON,
Chairman of the Commission of Conservation, Canada.

In connection with fisheries and game, the aim of the Commission has been to collect information to form a basis for future work. This has been published in a report in 1911. An analysis is given of the British North American Act, showing the jurisdiction exercised over fisheries by the Dominion and each of the provinces; while a digest has been made of federal and provincial fisheries laws and regulations. The report also contains the results of an investigation into the Canadian oyster industry.

The public health division is investigating housing and town-planning conditions in Canada. Information is being compiled showng the park area of each city, and indicating what power, if any, urban municipalities have in determining how areas on their outskirts may be subdivided into lots. From investigations already made it has been ascertained that Canada is face to face with a serious slum pro-

blem, and Dr. C. A. Hodgetts, medical adviser of the Commission, has spent several months in Europe investigating housing conditions and town planning there. A thorough investigation is also being made of infantile paralysis, a disease that has recently become alarmingly prevalent in Canada.

The greater part of the work of the Commission on waters and water power is embodied in a report on the water powers of Canada by Leo G. Denis and Arthur V. White. This is a very exhaustive work, which, after recounting the general economic conditions regarding water resources, gives comprehensive and detailed information respecting the water-powers of each province. The head of the fall, the amount of power now developed, the amount possible of development, and the purposes for which the power is used are given, wherever the information is available, for each known water-power in Canada. In addition, a summary of the laws of each province and of the Dominion governing the disposal of water-powers is included. It is hoped that this information in readily available form will do much to encourage the development of Canadian water-powers.

The available data for the Western provinces was found to be very incomplete, and, accordingly, Mr. L. G. Denis, the hydro-electric engineer of the Commission, and Arthur V. White were detailed to investigate these powers during the past summer. Mr. Denis, last summer, surveyed the powers in northern Alberta, and Mr. White, with several assistants, was engaged in surveys of the water-powers of southern British Columbia. Through the courtesy of the Honourable W. R. Ross, chief commissioner of lands for British Columbia, the information respecting water-powers obtained by provincial engineers employed by the water commissioners in connection with the disposition of water rights was placed at Mr. White's disposal.

Additional information of value on the water resources of the province will be brought out in stream-gauging operations to determine the amount of water available for irrigation purposes. These surveys are being undertaken to comply with the provisions of the British Columbia water-power Act, and are being carried out under the direction of the Hon. Mr. Ross.

The Commission has reported on various projects for the development of water-powers that have come up before parliament. The most important of these was the application made by American capitalists to dam the St. Lawrence at the Long Sault rapids. This power is estimated to be capable of generating 600,000 horse-power, and the projected plans gave a minimum consideration to Canadian interests, it being proposed to develop only one-sixth of the total power on the Canadian side. On grounds of public policy the Commission opposed the application, and thus far successfully. The Commission also reported adversely on the incorporation of the International Waterways Canal and Construction Company, a scheme for canalizing the waterways between Lake Superior and the head waters of the Saskatchewan, which, it was feared, would interfere with public rights. The Nelson River Railway Company sought to gain possession of valuable water-powers, including the Grand Rapids of the Saskatchewan—the most valuable water-power near the settled area between Lake Superior and the Rockies. At the instance of the Commission it was modified so as to be unobjectionable. The Nipigon-Albany Canal and Transportation Company applied for a charter that would have given them control of the powers between the mouth of Nipigon River, on Lake Superior, to the mouth of the Albany, on James Bay. Warned by the fate of the International Waterways, Canal and Construction Company's bill, its promoters withdrew it. Other projects on which the Commission reported were: the St. Lawrence Power Transmission Company, and the application of the Minnesota and Ontario Power Company to export power from Fort Frances, Ontario. In all these cases the Commission has endeavored to follow the policy it has laid down for itself in this regard, viz.:—

That no unconditional titles should be given to water-powers, but that every grant or lease of powers should be subject to the following, among other, conditions:—

1. Development within a specified time.
2. Public control of rates.
3. A rental, with the power to revise same at later periods.

In view of the heavy losses due to the destruction of property from fire in Canada (from seven to ten times as great as in the larger European countries) an investigation is now being made of this subject by Mr. M. J. Patton, assistant secretary of the Commission. If means can be devised to lessen these losses it will mean a large saving both in property and insurance rates.

CONTROLLABLE DUMP BUCKET FOR PLACING CONCRETE IN THIN WALLS.

In the construction of concrete work contractors have often found it difficult with the ordinary drop bottom bucket to place concrete in thin walls, as most of these buckets on the market have uniformly sloping sides or the dumping mechanism is located on the front or discharge side where its operation is often interfered with by the reinforcement rods or forms.

With the idea of overcoming this difficulty a drop bottom bucket has been designed, the section of which is a right-angle triangle, the front or discharge side being vertical. It is evident by this arrangement that there is no interference from the steel reinforcement rods or forms in the operation of the bucket mechanism.

The construction of this bucket is very simple. The drop bottom which is slightly curved is about quarter of the length of the sloping side. It is operated by a handle, on the end of which is a cam bearing on an equal arm lever that connects through another lever to the drop bottom. The discharge of the concrete is readily controlled by the operator, who can let the concrete out in small or large quantities. In cases where thin layers of concrete are desired the operator can control the discharge and move the bucket forward or backward as desired, thus spreading the mass. The shape of the drop bottom is such that with a little experience the operator can throw the concrete through a steel system four to six feet wide.

This new bucket, while it was primarily designed for thin wall construction, discharging concrete readily in narrow forms for walls only 3-inch thick, without any waste of concrete or any extra handling, will be generally useful in all kinds of concrete work, and the shape of this bucket is such that very little scraping is needed after the batch is let out. The vertical face gives a clear fall to the batch of concrete, which draws the concrete down with such force that a scouring is produced on the sloping side and the bucket is cleaned completely. This is a point which means saving of time, and also saves the bucket from the hammering commonly needed to clean so many buckets on the market.

It has been used with success by Contractors J. B. Smith Company, in erecting the inclined concrete abutments for the overhead double track crossing on the Western and Atlantic Railway at McCarty, Tenn. The bucket has just been put on the market by the manufacturers, Ransome Concrete Machinery Company, Dunellen, N.J.

MINING IN BRITISH COLUMBIA.

BY ROBERT R. HEDLEY.

The British Columbia mining industry has made considerable substantial progress during 1911, though the tangible results are not yet very evident. In all directions, there is a promise of more activity throughout the province in the next twelve months, and there is no doubt that the very decided favorable development now assured in many properties will greatly stimulate this.

This development has been quietly proceeded with, by substantial financial companies, and it is not easy to get particulars of results achieved. Coal must in the near future gain for us a great reputation.

Men of high standing in the mining world have said there may be a second Pennsylvania around the headwaters of the Skeena River. Certain it is that there are large areas underlain by several seams of coal of very satisfactory thickness, and of exceptional quality. Authorities class it as high grade anthracite. After the Toronto syndicate the National Finance Company, Limited, of Vancouver, was among the first in the field and secured some very valuable areas. Other Vancouver as well as Ontario and Quebec capital is interested. The importance of the field, and the need of its produce, ensure the speedy providing of transportation. There is, of course, coal distributed through a wide section of the Skeena River country, but it has not received so much attention as that mentioned.

Copper River has an area of great promise which is owned and being developed also by the National Finance Company, Limited. Graham Island, doubtless, has large areas underlain by coal, but though known for the past half century, the only development is at camps Wilson and Robertson, and nothing is very definitely proven. At the present time, however, drilling is in progress by people of weight and experience. It is generally accepted that the quality will vary greatly from anthracite near the eruptives to lignites, also the ash will be a variable figure. On Vancouver Island there has been no material change since the Dunsmuir property changed hands.

The production is about the same as of recent years. At Nicola Valley, the conditions are constantly improving and the field becoming more important. The areas to the south, in the Similkameen, Tulameen district have coal of varying character, but generally low in grade. Development as yet is confined to one property. The Crows Nest and Alberta colliery output has been sadly curtailed by the ill-advised and unfortunate strike now happily settled. Vast new fields are under process of development from Elk River to Northern Alberta, which promise to amply supply the needs of the country tributary to that section, with coal of any variety in any quantity.

At the Coast, the Marble Bay Copper Mine on Texada Island has continued to produce very profitable ore at the rate of from 1,000 to 1,200 tons per month. It is noteworthy that this mine, though operating at a depth of over 1,000 feet below sea-level, still produces the higher sulphides of copper, bornite and chalcocite, and maintains its gold and silver values. The ore shoots have been practically continuous from the surface. The property is owned in Tacoma, Wash.

The Britannia Mine, in Howe Sound, thanks to the faith and persistence of the owners, aided by the unusual energy and capability of their manager, Mr. R. H. Leach, has now an assured future, with a very large tonnage of profitable ore blocked out, and a very much greater quantity, proven by partial development and diamond drilling.

The Hidden Creek group of mines is situated on Goose Bay Observatory Inlet, a branch of Portland Canal. In 1907 this was a prospect pure and simple outcropping as a vast pyritous deposit, offering bluffs of 200 feet in height and width somewhat greater. It was apparent that a large tonnage of ore could be mined to carry from four to five per cent. copper, and that lower grade ore would be developed in great quantity. It impressed me as offering great possibilities for profitable operation if developed and equipped for economical mining and smelting. The character of the ore and its favorable situation were most promising.

Last year this property was purchased by the Granby Consolidated Mining, Smelting and Power Company, who have further developed it, and are now planning the erection of a smelting plant with a capacity of 2,000 tons per day. The measure of their success depends on their metallurgist. There is every reason to expect unusual results in operating costs of a different character, and not yet well developed is the Surf Inlet Gold Mines on Princess Royal Island, now being developed by a local company. In proximity to this, as distances go in the Coast district, Messrs. Martin and Shannon have done much costly and difficult work in tracing a quartz vein, that, so far as proven, has wonderful shoots of high grade copper-gold ore. This is six miles from the head of Khutze Inlet.

It is conservative however, to state that the limited development so far accomplished, indicates probable ore in excess of 100,000 tons, with gold values approximating ten dollars per ton. This should yield a profit, according to the equipment and tonnage treated, of four to five dollars per ton. A force of men will further develop the property this winter under the supervision of Mr. F. M. Wells, to whom with Mr. A. B. Clabon, is due the credit for the resuscitation of this promising property. A grand waterpower of untold capacity and cheaply developed, is an important asset of this company.

At Portland Canal, there has been but little accomplished except for two properties, though there are many properties waiting development that have every promise of winning out. The Portland Canal Mining Company's property is well developed and equipped with a modern concentrator. The margin of profit, however, is not great and the plant too small as yet for substantial results.

The Red Cliff has insufficient development to estimate its ore reserves, or to enable it to enter the producing list. The lower tunnel has cut the ore at a depth of 275 feet below the main outcrop and a raise connects. Development is under progress and the outlook is hopeful.

On the Salmon River are some very promising prospects, indicating large bodies of ore which, though low grade, will probably prove profitable.

There are many excellent opportunities for exploitation, notably some deposits of copper ore similar to that of the Britannia, between the headwaters of Seymour Creek and Howe Sound, and up the Squamish River as far as Green Lake.

Lillooet has in the past two years received increasing attention from prospectors and others, and there are indications that the general condemnation of that district, which followed the Golden Cache fiasco, was unwarranted.

Of the country known generally as the Hazelton district and comprising all that between the Telkwa, Copper and the Babine Rivers, there is little to say and much to expect. This district has much promise of ore of great variety, some of the silver-lead properties seeming to stand the test of development very well.

Of Kamloops, it is still playing the waiting game. Let us hope it will be worth waiting for. I believe it will if properly handled.

The Boundary with its two smelting plants always on the eve of breaking the already low record of costs and high record of production, has this year been handicapped by the failure of the coke supply. Granby thought it unwise to continue to bring coke from Pennsylvania and shut down the mines and plant, while the British Columbia Copper Company worked right through on Pennsylvania coke.

It is extremely gratifying that both these companies are extending their operations to other fields, the Granby having established themselves on the Coast at Observatory Inlet, and the British Columbia Copper are again looking into the copper camp tributary to Princeton, as well as investigating gold property on Slocan Lake.

The Consolidated Mining and Smelting Company of Canada, with their ample plant at Trail, are producing lead, silver, gold and antimony, as refined products, but the majority of their gold still goes with copper matte to the refinery in the United States. This plant, embracing all that is most modern in the copper and lead smelting and in the electrolytic treatment of argentiferous and auriferous lead bullion, draws supplies from a number of its own mines, as well as serving the country as a custom smelter. Among land; St. Eugene, Sullivan, East Kootenay, Molly Gibson and Richmond Eureka in Ainsworth-Slocan, Slocan. Others there are of lesser importance as yet, though the big ledge or deposit of carbonate of lead near Sheep Creek, may ere long be claiming recognition. The recent development of the War Eagle has opened extensive stopes of unusually high grade ore at several levels, including the lowest, an encouraging feature.

Nelson district looks forward to the opening of the Toad Mountain mines, including the old Silver King and Dandy, under new auspices. The capitalists backing this venture are advised by Messrs. C. Nelson Fell and M. S. Davys, both of whom have experience on the Mountain. Sheep Creek has not made as substantial progress as was looked for. The Mother Lode ceased mining to erect a modern mill which is expected to make a handsome profit.

The Mother Lode is the one mine really developed and ready for milling, though the Nugget could probably be rendered so by moderate, judicious expenditure.

In Ymir camp the old Wilcox has changed hands and is being well equipped. Recent development has been satisthese are the War Eagle, Centre Star and Le Roi, of Rossfactory. The Yankee Girl too, has passed from the receiver's hands to those of a strong aggregate of capital, headed by Mr. Bob Mabry, of Spokane. This mine has under the old regime shipped a handsome tonnage of ore to Trail, which has averaged about $20 per ton, chiefly in gold, but at a low margin, owing to lack of proper development and equipment.

Below Salmo, the Arlington at Erie continues to produce a small tonnage of sorted ore with a narrow margin of profit. Conditions are none too favorable and the operators are deserving of great credit.

Nearer Nelson, the Athabasca and Poorman-Granite have rendered a good account, milling steadily a fair tonnage of good grade. Rossland, in addition to the mines owned by the Consolidated, can point with pride to the record of the Le Roi No. 2, which has been a continuous producer of higher grade gold-copper ore, with a handsome profit.

West of the Boundary, though the field is wide and the promising properties are many, the only producer of note is the Hedley Gold Mines at Hedley, on the Similkameen. Under the new management this plant has been remodelled and is now an efficient and modern milling and cyaniding mill. This year's results will in all probability total better than 50,000 tons of $12 ore, and will have something over for surplus after paying $240,000 in dividends.

In the Slocan there is the strongest possible feeling of confidence in the future. Six years ago the Rambler-Cariboo drove a deep level tunnel, 4,000 feet, to tap the ore 1,400 feet below the surface and 600 feet below the lowest workings. Success was not, however, immediate, and it is only this year that they really see their reward. Always a high grade silver lead ore, the ore now developed is greater body and higher grade than ever before. Forest fires in 1910 destroyed the railway, and shipping must wait till transportation is restored. As a result of this deep level success, the Payne Mine, now opened to the eighth level, is to be provided with a deep level about 3,300 feet long, giving 675 feet of virgin ground. This is undertaken on the recommendation of Mr. W. E. Zurickey, manager of the Rambler-Cariboo, and to him will be entrusted the engineering of the project.

The Whitewater Deep has this year connected its deep level tunnel by raise with the upper levels, and exploratory work so far has been very encouraging.

The Slocan Star group under a new company, has also started a deep level which will deliver ore direct to the concentrator. The tunnel will be 2,300 feet long, and give 600 feet of virgin ground on the dip of the vein.

On Slocan Lake, the Standard, recently acquired by Patsy Clark, has in its deep levels, spectacular stopes of over 20 feet of galena practically without gangue, and very extensive bodies of concentrating ore for which a mill is being installed. The Van Roi will this year make a very satisfactory record from its milling operations, treating 100 to 125 tons daily. The development is extensive and good and the ore reserves assure a long life.

The Hewitt-Lorna Doone group of the Silverton Mines, Limited, is well developed by seven levels, several of which pierce the mountain from west to east. No. 6 connects with the upper terminal of the tram, which delivers to the mill on Four-mile Creek.

COST OF BITUMINOUS COAL MINING.

At the Chicago meeting of the American Mining Congress, B. F. Bush gave the following as the averages of answers to questions he had submitted to the leading bituminous-coal operators of the United States:—

1. Capital invested in business. For each ton of coal sold $1.41 is invested in land, machinery and equipment.

2. Average total cost of production, labor cost (mine workmen only), administration and average selling price at mine. Total cost in 1910 averaged $1.07, including 95c. for labor and supplies. Administration cost 12c. per ton, including office and sales expenses, insurance, taxes, legal advice, etc., but not including depreciation, interest nor profit. Average selling price at mine, $1.11 per ton.

3. Estimate of increased cost necessary to meet demand for conservation. Two to 15c. in different fields, averaging perhaps 5 cents.

4. Depreciation per 100 tons daily capacity. About 4c. per ton covers the average depreciation of coal reserves and plant.

5. At what price must coal sell? The increased prices necessary for a fair return on the money invested range from 5 to 25c., averaging 12 cents.

Over-production, over-capacity and ruinous competition were discussed at length. Two possible remedies were suggested.

District sales agencies to control prices and output, under subjection to an interstate coal commission; government assistance in encouraging foreign markets.

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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THE UNIVERSITY AND THE RAILWAYS.

The man in the street does not usually see any intimate connection between the work of the Engineering School and the railways. He, of course, appreciates the fact that a great many of the men in executive positions on the railways have had an engineering education. However, the fact that many of the engineering schools have been developing and analyzing many problems of great practical interest to these corporations is not very well known.

Dean Goss, of the Engineering Faculty of the University of Illinois, in a recent address to the St. Louis Railway Club, refers to a number of these problems, which are being solved in that college.

The school of railway engineering and administration is developing on its engineering side many interesting problems. For example, a knowledge of the forces which must be applied to maintain the motion of railway trains is a matter of fundamental importance in many of the problems of the railway. The University of Illinois was almost a pioneer in this field of research. In conjunction with the Illinois Central and the Cleveland, Cincinnati, Chicago and St. Louis, it designed and constructed a series of dynamometer cars, each new design overcoming defects which had appeared in its predecessor. The third car of the series has now been in successful operation for the past three years, and it has served in the development of the most accurate array of data concerning train resistance which has thus far been published.

Another important line of investigation has led to the development of a system, not entirely original, for detecting defects in track bonds on electric lines. An electric test car has been equipped with apparatus designed to record automatically the condition of every bond it passes over. The record gives the electrical resistance of the joint, in comparison with the resistance of a short length of solid rail. The results are registered on a web of paper, which unrolls as the car proceeds, a half-inch length of paper corresponding to a rail length. In action the car is allowed to proceed at a moderate speed, the record for each joint being made automatically as it is passed, while an attendant operating a push-button controls a supplemental record representing the location of the numbered line poles as they are passed. An examination of the record enables one at once to pick out and locate the imperfect bonds. The test-car has the form of an interurban car, the interior being fitted up with the instruments necessary to make it a laboratory. It is designed for the instruction of students and for the solution of problem of interest to the electric traction interests.

The university is giving generous attention to problems underlying the design of railway equipment.

A standard Master Car Builders' drop testing machine has been installed, which is designed especially for use in testing couplers, coupler knuckles and draft gears, but is available for use in testing materials of many different sorts. The machine consists of a hammer weighing 1,640 pounds, sliding in two upright guides 50 feet in height, between which it is allowed to fall upon the test specimen supported by a massive anvil resting upon a foundation through the medium of heavy springs. By the use of this machine students are instructed in the process of making the proof tests of the Master Car Builders' Asosciation, and are enabled to gather impressions concerning the severe treatment which must be withstood by couplers, draft gears, bolsters, axles and other details entering into the construction of freight cars.

Another detail in car design which of late has demanded attention is the brake shoe. There has been installed a brake shoe testing machine possessing equivalent characteristics to those of the original Master Car Builders' machine, but one which in its details is a much more serviceable machine. It consists primarily of a shaft carrying a fly-wheel and standard car wheel, which may be either steel or cast-iron. The shaft is driven at any desired speed by means of an independent engine. By reason of the presence of the fly-wheel there is available at the surface of the car wheel, when in motion, the same amount of energy as is impressed upon one wheel of a 60,000-pound capacity car in service under like speed conditions. The shoe to be tested may be applied to the wheel with any desired pressure up to a maximum of 24,000 pounds. The tangential pull of the shoe, which develops when the shoe is thus applied to the moving wheel, is transmitted to a dynamometer, where it is recorded upon a moving paper chart. By these means the coefficient of friction of any shoe may be determined under different conditions of speed and shoe pressure. The machine likewise serves to permit the determination of shoe wear and wheel wear under any condition that may be prescribed.

The last Legislature appropriated to the university $200,000 for a building and equipment for its college of engineering. The trustees have determined that the building shall be devoted to transportation interests, and in the working out of plans it has seemed best to provide for a group of buildings.

After reading what Dean Goss states is being done for the practical solution of railway problems by the University of Illinois, it appears to us that there are many ways in which our Canadian universities can develop the practical side of their work.

The faculties of engineering in Canada are rapidly increasing their staffs, and a great deal of public money is being invested in laboratories and laboratory equipment. These laboratories and equipment should be used for the public benefit to as large an extent as possible, and for that reason the work done in them should be kept along the lines which will be of benefit to the public. The danger always will be of the laboratory work given in connection with the engineering courses becoming too academic.

EDITORIAL COMMENT.

What has become of the Royal Commission on Technical Education? We would suggest that it is nearly time they handed out their report.

* * * *

The annual meeting of the Canadian Society of Civil Engineers is to be held in Montreal, January 24th, 25th and 26th. The programme of the meeting will be found in this issue of The Canadian Engineer. Every member should make an effort to be present.

THE DINNER OF THE FACULTY OF APPLIED SCIENCE, UNIVERSITY OF TORONTO.

The twenty-third annual dinner of the Faculty of Applied Science and Engineering, University of Toronto, will be held on Thursday, January 18th, in Convocation Hall, at 8 p.m.

Among the speakers expected to be present to address the students are Major R. W. Leonard, chairman of the Transcontinental Commission; the Hon. Adam Beck, chairman of the Hydro-Electric Power Commission; Mr. G. H. Duggan, Chief Engineer of the Dominion Bridge Company; Mr. W. H. Hearst, Minister of Mines of Ontario, and many other prominent men. It is expected that there will be a good turnout of the graduates as well as of the students.

PROGRAMME OF THE TWENTY-SIXTH ANNUAL MEETING, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting for the election of officers and members of council for 1912, and for the transaction of business, will be held as follows in the rooms of the society, 413 Dorchester Street West, Montreal.

Wednesday, January 24th.—10 a.m. Meeting for the nomination of scrutineers, receiving the report of council reception and discussion of reports of committees, and transaction of the general business of the society.

1 p.m. Adjournment for members' luncheon in the Windsor Hotel, Montreal, to which the visiting members are invited by the members resident in Montreal.

3 p.m. Continuation of the business meeting for the discussion of reports, etc.

4 p.m. An address by the retiring president, Mr. C. H. Rust.

8 p.m. Address by Dr. H. T. Barnes on "Iceberg Detection in Navigation," in the lecture hall of the Chemistry Building, McGill University.

9.30 p.m. Reception by the president and members of council in the Engineering Building, McGill University, and inspection of the laboratories and workshops.

Through the courtesy of the Board of Governors of the University, the building has been placed at the disposal of the society for this evening. Members and ladies accompanying them are invited to the reception and lecture. Cards will not be issued.

Thursday, January 25th.—Two parties will be formed for the purpose of visiting engineering works.

(a) The Angus shops. By the courtesy of the Canadian Pacific Railway Company, a special train will convey this party to the works, leaving the Windsor Station at 10 a.m. Dining cars will be attached to the train, and luncheon will be served during the inspection of the works.

(b) The works of the Dominion Bridge Company and the Canadian Car and Foundry Company. By the kindness of the Montreal Street Car Company, cars will be in waiting at the Windsor Hotel, and will leave there at 10.30 a.m. sharp, for Dominion. The Bridge Company will lunch this party at 1.30 p.m., and the works of the Canadian Car Company will be visited on the return journey.

8 p.m. Annual dinner in the Windsor Hotel.

Friday, January 26th.—10 a.m. Meeting for the reception of reports of scrutineers and conclusion of the business of the annual meeting.

3 p.m. Meeting of council.

By the kindness of the railways of the Eastern Canadian Passenger Association, members and their families who have paid a full one way first-class fare going to the meeting in Montreal, will be returned free on presentation of a standard convention certificate signed by the ticket agent from whom a ticket has been procured at the point of commencement of the journey. The certificate is to be endorsed by the secretary of the society, and to be vised by a special agent of the Passenger Association who will be in attendance at the meeting from 3 p.m. to 6 p.m. on Wednesday and Friday, January 24th and 26th. A fee of 25 cents will be charged by the

Passenger Association in each case. Tickets may be purchased and are available three days before the commencement of the meeting, and the return journey may be made three days after its conclusion.

The Canadian Pacific Railway and the Canadian Northern Railway will grant a further extension of time to persons residing west of Fort William, making this free return available for 15 days after the close of the meeting; the ticket to Montreal having been purchased at any time and receipt obtained therefor on the standard convention form as above.

Tickets to the luncheon may be purchased at the rooms of the society. Prices: Luncheon $1.50 to resident members, dinner $3.00. C. H. McLeod, Secretary.

SILVER AND GOLD MINING IN ONTARIO.

BY H. E. T. HAULTAIN.

During the past year Cobalt has proceeded along the steady course of middle age without any remarkable occurrences. With the good properties the luck has held and new ore bodies have been discovered in proportion to the amount of exploration work carried on. The output has been steady and increasing and the price received for the silver was higher than during the previous year. Perhaps the most noteworthy event has been the completion and successful operation of the mill at the Nipissing designed by Charles Butlers for the treatment without smelting of the high grade ores of that company. No particulars have been made public but apparently the process is mainly amalgamation and lixiviation which recover the silver as bullion and leave the cobalt and arsenic as a tailings product to be subsequently re-treated when the market justifies.

Nothing has developed during the year to raise any reasonable hopes of finding extensive ore bodies below the Huronian. Cobalt camp is a notable example of local geological conditions sharply defining the depth beyond which commercial values are very unlikely to extend. That a young camp in a restricted area should produce sixteen million dollars worth of metal in a year is remarkable, and it is still more remarkable that nearly all this output should come from above the 250 foot level. Nearly all of the final total output of Cobalt is to be expected from these upper levels. If this were not the case, if the lower limits of the ore bodies were indefinite the Cobalt stock market would be in a very different state. The output this year must be practically at the summit and we may expect either no further increase or more probably a decline in annual returns, a decline which at the first will be gradual. The output of silver from Cobalt for 1911 probably exceeded sixteen and a half million dollars in value.

Gowganda, to a limited extent, is slowly recovering from its horrible wild-cat handling. Ore concentration is in steady operation, making regular shipments on a good pay ing basis. Steady progress with occasional shipments is be ing made on two or three other properties. Besides these there are several good prospects in this district which may ultimately be saved out of the wreckage. Other camps in the Elk Lake district are quiet.

With a gold camp the conditions are different. It is not a case of shipping a high-grade ore to smelters, but rather a treatment at the mine of a comparatively low-grade ore. This calls for extensive plant which takes money and time to build. As the plant is almost without value when the mine is exhausted, it is a business-like policy to make sure of the quantity and quality of the available ore before commencing work on a reduction plant.

In Porcupine during the past year progress has been remarkable for its character and its extent. Porcupine has done this for Ontario—it has caused experienced miners and mining financiers to flock to the district as they never did before in Ontario. The result is that the district is being properly explored and developed. It is true there have been and are wild-cats, some very rotten ones and some very ordinary, but these are unavoidable. The more important properties are being well handled and there are results to show for the money expended. The awful fires of the summer delayed work, caused a pitiful loss of life and a rather serious loss of money, but the camp itself is in many ways better off on account of it. The fire disaster checked a flaring promotion boom that would have done much harm to the mining industry.

The only gold produced to date has been from small tentative mills. The spring and early summer will see the beginnings of a steady and growing output. Two large mills, to cost when completed, more than half a million dollars, are being erected. Several smaller ones are under construction or have been ordered.

There are several certain successes in the camp and these all lie within a comparatively small area. Outside of this limited area there are many good probabilities and possibilities over a wide section of country, a section that grows as exploration work extends.

Geology has no bad news for Porcupine as it had for Cobalt. The limiting depth to which values will extend is indeterminate. This does not mean that the values will of necessity continue to go down indefinitely to great depths, it simply means that there are no reasons why they should continue or stop; it is a matter of chance just as are the extensions laterally, and the only way to settle the question is to go down and see.

The railway has now reached the heart of the district and this means much in many ways. There ought to be a healthy activity in the farming line, for there is much excellent land along the railway.

Swastika camp to the south-east of Porcupine is giving good promise on a smaller scale, and gold bearing quartz has been reported from many widely different points. Long before Porcupine was discovered it was truly said that there was more gold than silver in Ontario. Gold is scattered very widely, but only in a few localities had it been sufficiently concentrated to pay to work. Porcupine is one of these; there is no reason why there should not be more; the geological conditions are favorable over a wide extent of country.

Larder Lake is again attracting some attention. It has not yet recovered from the mishandling it got in its boom days. There is plenty of gold scattered over a large area in Larder Lake district, but it is hard to find a pay zone. It needs exploration by competent men.

Very interesting and satisfactory results are greeting the experienced men who are tackling some of the old mines and prospects in the Port Arthur district. The methods and men employed in the early days of this district might not only overlook good things but could easily blacken the chances of any good things they did uncover.

Ontario offers a fine field to the prospector. There are large accessible areas open to him. Cobalt and Porcupine show him the possibilities and there has never been time or place better for him in the way of making deals or getting assistance in his development work. On the other hand the absurd figures asked by prospectors for bare prospects have very materially held back some promising districts. The wild-cat promoter has set a fictitious value on prospects.

On the whole the silver and gold mining industry of Ontario is in a very healthy condition.

CONTRACTS FOR THE SUPPLY OF ELECTRIC POWER FROM THE POWER USER'S POINT OF VIEW.

III.

By H. E. M. Kensit, M.I.E.E.

We have now considered the matters of power factor and peak load and the methods of measuring them. (See previous article.) Other points in the same connection that should be provided for in drawing up a contract are as follows:

The power company usually requires a statement as to the maximum power that is likely to be required, in order that they may be prepared for all contingencies; also a guarantee as to the minimum amount that shall be paid for whether taken or not.

This minimum guarantee is reasonable, in that the power company must expend capital for generating plant and transmission lines to provide for the maximum, and must have some guarantee to justify the expenditure.

For the power company's benefit the probable peak load is usually estimated at a safe figure, and, on the other hand, the customer wishes to keep the guarantee as to minimum to be paid for as low as possible.

A margin of say 25 per cent. between the two is a fair business risk to the power company, especially as this risk is usually distributed amongst a number of customers, and the average result usually comes out better than anticipated owing to the growth of business and therefore of output and power taken.

This growth of business may necessitate the use of more power than the user would have felt justified in contracting for at the time of making the contract, and in the case of such contracts for a term of years, the customer should be protected as to any reasonable increase during the term of the contract.

The contract should therefore provide:—

(1) That the customer shall be allowed to exceed the agreed maximum amount of power to be taken by 10 per cent. without previous notice and at the same rate of charge.

(2) That additional power shall be furnished by the power company, under the terms and conditions of this contract, and at any time or times during the life thereof, up to the extent of a total of ..... horse-power, upon receipt by the power company of ..... months' notice in writing as to the additional power required.

The following are some sample clauses on these points from actual contracts:—

(1) "The power company agree to deliver ..... horse-power at the works of the customer by the ..... day of ..... and at the expiration of three months' written notice, which may be given at any time during the continuance of this agreement, to supply from time to time additional power in blocks of not less than ..... horse-power until the total amount so supplied shall amount to ..... horse-power.

"The customer agrees to pay for three-fourths of the amount so supplied or held in reserve whether he actually uses the same or not, and at no time to take more power than the amount so agreed upon and held in reserve by the power company."

(2) "The power company agrees to sell and deliver to the customer and the customer agrees to purchase and take from the power company for a period of ..... years from the ..... day of ..... electric energy to the amount of ..... electrical horse-power. It is further agreed that the power company will supply such additional power as may at any time be required over and above the amounts herein contracted for, and the cost of said power shall be on the same terms and at the same rates as for the amounts aforesaid."

(3) "The producer agrees to furnish continuously from the ..... day of ..... for ..... years, so far as reasonable diligence will enable it so to do, and for the operation of the consumer's industry only, not to exceed ..... horse-power of electric energy.

"The consumer agrees to pay the producer on the ..... day of each month for the energy furnished hereunder during the preceding calendar month, the sum of ..... dollars, and for additional energy taken by permission of the producer at the rate of ..... dollars per horse-power per month."

(4) "The producer agrees to furnish and the consumer agrees to take and pay for a minimum of ..... horse-power for the term of ..... years from noon on the ..... day of ..... The Consumer's maximum demand shall not exceed ..... horse-power without the written consent of the producer.

"The company will make every endeavor to supply any additional energy required, but it shall not be bound to do so upon less than six months' notice in writing, and in no case to supply more than it may have available and unsold from its then existing works."

A point of the first importance in regard to the measurement of the power used is the accuracy of the instruments when installed and their liability to get out of order afterwards. The instruments may have been supplied by a first-class firm and have been in perfect order and adjustment when they left the factory, but may be thrown out of adjustment in transportation or erection, or they may be wrongly connected, or influenced by magnetic fields in their vicinity, and the errors thus introduced may be quite large without the instruments giving any indication that would even lead to suspicion.

Experience has convinced the writer that no such instruments can be depended upon until they have been checked in position against standard instruments, and in his opinion this should be insisted upon as a condition of every contract. But even after this has been done the instruments are liable to alter as to their calibration or to get out of order from time to time, and it would be better still to provide that they should be re-checked in the same manner once a year. This is not an onerous condition. An electrical power company has usually and certainly ought to have the necessary portable standard instruments and can carry out such a test at small expense. Similar original and periodic tests are usually required by law in respect to house service meters, and are even more necessary for the large sums often involved in contracts for power.

Occasions, however, sometimes arise where the customer still has reason to doubt the accuracy of the meters, and is not satisfied to accept the check made by the power company, and to meet such cases it is usual to provide a clause that the customer may instal his own meters as a check and may require the power company to have their meters checked by an independent authority. This checking by an independent authority is expensive, and it is well to define by whom this expense is to be borne.

The following is suggested as a fair clause to cover the checking of meters, subject to modification to meet the conditions of each particular case.

"The necessary measuring instruments shall be installed and maintained by the power company, who shall, before using them as a basis of charge, furnish a satisfactory certificate that the said instruments have been calibrated in position against standard instruments, and who shall also

furnish to the customer tables or diagrams of the said calibrations.

"If requested in writing by the customer this calibration shall be repeated and diagrams furnished once in each year during the continuance of this contract.

"The customer shall be entitled to instal his own meters at his own expense as a check upon the power company's meters.

"The customer may at any time require the power company to have its meter or meters checked by an independent testing authority who shall be mutually agreed upon, or if there is failure to agree then the testing authority shall be named by ....., and on receipt of notice in writing from the customer that this test is desired the power company shall immediately have it carried out.

"Should such tests show the meter to be inaccurate by more than 2½ per cent. either way from absolute correctness over its working range, then the power company shall pay all the expenses of the test and shall adjust the current account for energy accordingly, but if the meter shall prove to be correct within the above limits, then the customer shall pay all the expenses of the test.

"Should the meter cease to record, then the charge shall be the same as that made for the previous corresponding period, plus, if necessary, an additional charge for any additional power used by any additional apparatus that the customer may have installed during the interval."

REPORT ON ELECTROLYSIS IN CHICAGO.

In the annual report of the Commissioner of Public Works of Chicago, just issued, is printed a report by Ray Palmer, consulting engineer, on the electrolytic damage to various underground metallic structures in different parts of the city caused by stray return current from the surface and elevated lines. Surveys made during August and September, 1911, showed excessive stray current in the neighborhood of the Illinois Street and Hill Avenue substations of the Chicago Railways Company, the Forty-second Street substation of the Chicago City Railways and at many points along the elevated railway structures.

The damage is said to include underground water pipes, lead cable sheaths, the metal in structural-steel buildings and the structural steel in bridges used by street railways in crossing the Chicago River. As a remedy for the conditions existing on the elevated structure the report recommends that large negative return cables should be placed on the structure and should be connected to the [illegible] at intervals of 300 ft. At the present time no return cables are used on any of the elevated structures in the city.

The existing city ordinance relating to the prevention of electrolysis is as follows:

"Ground return wires must be so arranged that the difference of potential between the grounded dynamo terminal and any point on the return circuit will not exceed 25 volts. The positive pole of the dynamo must be connected to the trolley line, and whenever pipes or other underground metal work are found to be electrically positive to the rails or surrounding earth, they must be connected by conductors arranged so as to prevent a flow of current from the pipes into the ground."

The report recommends that the ordinance be amended to read as follows:

"Ground return wire and rail circuits must be of such current-carrying capacity and so arranged that the difference of potential between any two points on the return will not exceed the limit of 12 volts. The railway companies must so equip their return current systems with insulated pilot wire circuits and voltmeters that an indicating reading may be obtained at any time showing the difference of potential between the negative busbars in each station and the extreme limits of the return circuit in the corresponding feeding district.

"The railway companies must protect all metallic work from electrolysis by the proper installation of a system equal to or better than a pipe and cable sheath drainage system consisting of insulated copper wires, pipe straps, ammeters, etc., which limits the maximum amperes drained from this subsurface metallic work to 10 per cent. of the total output of the station."

To operate within the limits required by such an amended ordinance the railway companies would be compelled to make one or more of the following improvements:

(a) Reconstruct all defective track work and install additional return feeders.

(b) Install a negative booster system.

(c) Install a return-current drainage system.

(d) Reduce the size of the power plant and substation feeding districts.

(e) Insulate the railway return circuits.

The report states that the most practical and efficient method of reducing electrolytic damage would be the installation of a pipe-drainage system. It recommends that all track bonds should be repaired and maintained in an efficient condition.

CANADIAN RAILROAD EARNINGS.

	Canadian Pacific Railway.			Grand Trunk Railway.			Canadian Northern Railway.		
Month.	1910.	1911.	Increase.	1910.	1911.	ncrease.	1910.	1911.	Increase.
	$	$	$	$	$	$	$	$	$
January	6,007,000	5,650,000	357,000	3,152,992	3,381,239	228,247	792,200	822,600	30,400
February	5,813,000	6,180,000	367,000	2,965,709	3,103,166	137,437	698,900	803,100	114,200
March	7,667,000	8,648,000	981,000	3,793,257	3,909,773	116,516	934,100	1,270,600	336,500
April	7,200,000	8,458,000	1,258,000	3,567,367	3,747,251	179,884	1,153,100	1,345,400	192,300
May	8,215,000	9,111,000	896,000	3,731,820	3,942,055	210,235	1,224,900	1,445,600	220,700
June	8,404,000	9,040,000	636,000	3,965,062	4,437,438	472,376	1,228,600	1,465,300	236,700
July	8,660,000	9,291,000	631,000	3,179,946	4,237,383	1,057,437	1,225,100	1,475,950	250,850
August	8,926,000	10,073,000	1,147,000	3,885,049	4,502,674	617,625	1,093,000	1,420,650	327,650
September	9,115,000	9,834,000	719,000	4,107,963	4,409,559	301,596	1,279,900	1,576,400	296,500
October	10,150,000	11,113,000	963,000	4,200,039	4,468,768	268,729	1,627,800	2,028,900	401,100
November	9,249,000	10,399,000	1,150,000	3,845,640	4,101,244	255,604	1,565,400	2,001,500	436,100

LONDON TRAMWAY AND GENERATING STATION.

The London County Council was constituted under the Local Government Act of 1888, its administrative area being over 120 square miles, and including some of the most populous portions of the Empire.

Probably no single authority has ever before exercised so many diverse functions as the London County Council, for it enters into practically every social activity of the London citizen from the cradle to the grave, handling anything from transportation to hotels.

The committee responsible for the control of the London tramway system is the Highways Committee, and this portion of the council's activities are principally dealt with in this article.

What is known as the London County Council Tramways consists of what was formerly a number of independent tramway undertakings operating within the county of London, together with certain new lines subsequently built by the council. Each of these companies owned from four to fifty miles of line, but gradually the council has taken over by purchase all the tramway companies within its area. The first transfer took place in 1895 and the last in 1909.

At the end of March, 1910, the system extended over 135½ street miles, of which 115½ miles were electric lines. The remaining 20 miles were at that time still worked by horse traction, but the latter have now practically all been converted to electricity.

The following table indicates the progress which has been made with the work of electrification. In some years it will be observed that while the amount of electrified lines increased, the length of horse lines also increased. This is accounted for by the acquisition by the council of other tramway undertakings.

Street mileage at end of year.	Electric traction in operation. Street miles.	Horse traction incld. lines in process of reconstruction. Street miles.	Total. Street miles.
March 31, 1904.....	19¼	69⅜	88⅝
March 31, 1905.....	26⅝	68¾	95⅜
March 31, 1906.....	30⅜	73⅝	104
March 31, 1907.....	58⅞	57⅞	116¾
March 31, 1908.....	68⅝	51¾	120⅜
March 31, 1909.....	84⅜	54⅛	129½
March 31, 1910.....	115½	20	135½

The above figures are indicative of the victory won by electricity over every other form of power, during the last 20 years. That unhappy animal, the tramway horse, meandered on its way for some time after experiments in electric traction had proved the infinite superiority of electricity, but the horse trams with their innumerable stops, delays, and inconvenience, at last proved intolerable and once the first step in electric driving was taken the rest was easy. A few horse trams are still to be seen in some outlying districts, but for all practical purposes the route is complete. Even in those busy parts of the Metropolis, where tramways are not allowed, the service is very largely carried out by motor omnibuses.

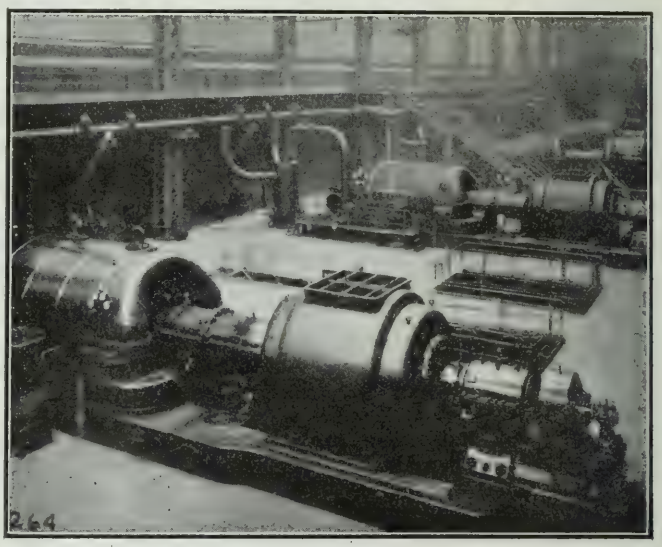
The total capital outlay of the London County Council Tramways amounted on the 31st March last to about $50,000,000. A report recently presented to the council, showing the results of the year's working during 1909-1910, gave the gross receipts of about $10,125,000 on the horse lines, viz., approximately $225,000, leaving a net surplus after payment on interest on capital outlay and for replacement of debt, of $960,000. The number of car miles run was 42,160,186, and the number of passengers carried 451,439,216.

The growth of traffic has arisen not merely from the increased mileage but also from the increase in the length of the routes electrified. Horse cars have only a small carrying capacity, and low-speed, and in London they are entirely at the mercy of the competition of motor omnibuses. Hence electrification in London has produced even more startling increases in the number of passengers than is the case in other towns.

Generating Station.—The electric generating station for the whole of London is situated at Greenwich, close to the River Thames. It was erected in two sections, and the site covers an area of approximately 3¾ acres.

The plant includes four vertical horizontal reciprocating engines coupled to three-phase alternators, of 3,000 kw. capacity each, four three-phase turbo alternators of 5,000 kw. capacity.

Two of the latter have only recently been installed. They were manufactured by the British Westinghouse Electric & Manufacturing Company, Limited, of Trafford Park, Manchester. An illustration of one of these sets appears below



5,000 kw. Turbo Alternator Sets Installed at Greenwich Power Station.

The two sets each comprise one 5,000 kw. 750 r.p.m. high pressure Westinghouse impulse type turbine coupled to one 5,000 kw. three-phase, 25-per., 6,600-volt, alternator, complete with Leblanc surface condensing plant and Leblanc auxiliaries.

The official tests of No. 7 turbine took place on the 8th, 11th and 13th January, 1911, after it had been eight months in regular service, with the results given below.

The guaranteed conditions were: Steam pressure, 180 lbs. per sq. in., with 120° F. superheat, vacuum 28½ inches (barometer 30 inches.)

No. 7 Set.

	25% Over-Load.	Full Load.	¾ Load.	½ Load.	¼ Load.
Test load in kws.....	6150	5165	3840	2572	1297
Guaranteed consumption..	——	14.5	14.75	16.0	19.5
Consumption obtained ..	14.74	14.30	14.60	15.67	19.31

This turbine has recently been opened for inspection after having been in operation for over 12 months, and it is found that the closest examination shows no trace whatever of erosion or corrosion, the blading being perfectly clean.

The normal plant capacity of the Greenwich generating station is 34,000 kw. The current is generated at a pressure of 6,600 volts, and is conveyed to various sub-stations over the tramway area.

The substations are provided with motor generators and rotary converters of a total capacity of 45,750 kw. transforming the current from alternating to direct at a pressure of from 550 to 600 volts.

The current is sent in the usual way from low tension switchboard through feeder cables which feed into the conductor rails in the conduit at half-mile intervals. On the over-head wire section the usual feeding arrangements for trolley wires are in use. The switches on the feeder panels in the sub-stations allow of the conductor bars in the conduit being changed so that either may be positive or negative, as required for the purpose of dealing with leakages to earth.

RAILROAD CONSTRUCTION THIS YEAR.

While about 2,000 miles of new railroad were built in Canada last year, the outlook for the present year is that as much if not more mileage will be added to the total. At the end of 1910, we had 24,730 miles. Last year the figures increased to approximately 26,500.

Sir Thomas Shaughnessy states that his road will probably build between 500 and 600 miles of new track this year and for an indefinite period. The main line from Medicine Hat westward for 534 miles is to be double tracked.

STEEL AS A TOWN BUILDER.
Canadian Northern Railway entering Stettler, Alberta, another link in Canada's transportation chain of 25,000 miles.

The contemplated construction on the Grand Trunk Pacific during 1912 is as follows:—

	Miles.
Main line	200
Brandon branches	16
Canora North	30
Regina boundary	155
Regina-Moose Jaw	45
Moose Jaw Northwest	50
Prince Albert	44
Battleford	48
Cut Knife	50
Biggar-Calgary	200
Alberta Coal	50
Mountain Park Coal	32
Melville to Watrous	75
Weyburn	60
Calgary to Coutts	50

The contract for five million dollars' worth of construction work in British Columbia for the Canadian Northern Railway was awarded to one firm who state that there is probably more railroad building going on in British Columbia than in any other part of the Dominion or the United States. They will begin active construction work on the new contract next spring. The plans call for 100 miles of road beginning about 50 miles above Kamloops, up north along the Thompson River Valley. When that is finished the Transcontinental chain of the Canadian Northern Railway will be practically completed.

Construction will commence on the Canadian Northern line from Toronto to Hamilton next spring.

The Canadian Pacific Railway is asking for parliamentary authority to construct new lines in Saskatchewan and Alberta. The Canadian Northern are seeking powers to build lines in the Peace River District, Alberta.

A large number of new railroad schemes are in the "charter" stage.

OUTLOOK IN ONTARIO MINING DEVELOPMENT.

By Thos. W. Gibson, Deputy Minister of Mines, Ontario.

During the past few years the advance in the mineral production of Ontario has been rapid, as the following figures show:—

Year.	Value of production.
1905	$17,854,296
1906	22,388,383
1907	25,019,373
1908	25,637,617
1909	32,981,375
1910	39,313,895

The statistician is rarely justified in venturing on the realm of prophecy, but the upward tendency of the curve described by the growth of mining in Ontario points strongly to still greater things in the future. It can hardly be doubted that the extension of prospecting into northern Ontario, now being rendered possible through railway construction, will bring to light new mineral fields probably as rich as any that have yet been found. The discovery of one such field leads almost as by a law of nature to the discovery of others. Silver Islet led to Rabbit Mountain and Beaver; Copper Cliff and Stobie to Creighton and Crean Hill and Garson; the Helen mine to the Josephine and Magpie; Sultana to Mikado; Cobalt to South Lorrain and Gowganda, and latest of all to Porcupine. Nor do the pre-Cambrian formations possess a monoply of mineral wealth; the Devonian and Silurian strata of southwestern Ontario have for years yielded goodly supplies of petroleum, natural gas, salt and gypsum. Petroleum may be declining in production, but that there are reservoirs, great or small, yet untouched, seems to be shown by the striking of oil in paying quantities a short time ago in Onondaga township, and the field for profitable production of natural gas appears to be steadily widening until it promises to cover a large part, if not the whole, of the northern and eastern shores of lake Erie. These stratified rocks have their counterparts on the slope leading down to James bay. Already gypsum in large deposits has been located there, and it would seem not unreasonable to entertain the hope that the future inhabitants of the clay belt north of the height of land may find it possible to light their homes with oil, cook their food with natural gas, and cure their pork with salt, all derived from the rocks underlying the farms from which they harvest their crops.

IRRIGATION BY PUMPING.*

By H. J. Kennedy.

In the development of an irrigated country, the lands first irrigated are naturally those which can be reached by gravity ditches; as these become settled and land values increase there comes a point where it pays to pump water on to lands lying too high to be reached by gravity flow. In irrigation by pumping, the efficiency of the use of water capacity takes on an added importance, for pumping is expensive, and the higher the irrigation duty obtained from a unit of water, the more land can be irrigated with a plant of given capacity and with a given power consumption.

As an instance of duty under a pumping system may be mentioned a certain large district in the interior of Washington, for which experts have concluded a rate of water pumped of 0.007 cu. ft. per second per acre, or 143 acres per second-foot, to be a reasonable amount. If 10 per cent. of this be lost by seepage and evaporation, the rate of application at the land becomes 0.0063 sec-ft. per acre, 4.5 acre-ins. per month, or 158.7 acres per sec-ft. But of course what is a fair allowance under some conditions of soil and drainage may be a great excess in others.

The next consideration when seeeking pumping economy is to reduce the unit cost of power as low as possible. This is attained by using apparatus of high efficiency, or by using cheap sources of power, or both. Falling water, in modern times as of old, furnishes a highly appreciated source of power. Quite a number of water power developments for irrigation pumping have been made or projected, both on large and small scales.

As examples of the large ones may be mentioned, in California the extensive system of the Mt. Whitney Power Company, comprising four power stations, on the Kaweah and Tule Rivers, which flow from the Sierras into the San Joaquin Valley, and a steam auxiliary generating plant; the total capacity of these plants is 8,850 kilowatts, which is conveyed by a network of transmission lines and utilized chiefly in pumping water by plants scattered throughout the valley, the area watered at present being about 18,000 acres.

In Idaho the power development at the diversion dam of the Minidoka project on the Snake River, the total capacity being divided into five generating units of 1,200 k.w. each, the irregular area under the pumping system being 49,900 acres.

In Washington a fraction of the 90,000 horse-power available on the great Columbia River at Priest Rapids has been developed by the Hanford Irrgation & Power Company, and utilized for pumping water from a different point on the same river to about 16,000 acres of land on the plateau above the river. This is an interesting example of private enterprise going into a region which was nothing but a vast treeless desert with a big river flowing through its midst and no population to speak of; putting the forces of nature to work and developing a new country out of the desert. It is still new and some particulars may well be included here.

The Hanford Power and Pumping Development.—The property has recently been taken over by the American Power & Light Company, but is still best known locally as the Hanford plant. The first generating unit was installed in 1909 and the second in 1910.

The Priest Rapids power station was designed for a present capacity of 2,600 horse-power, but provision was made for an ultimate development of 9,800 horse-power, with a minimum head of 18 ft. The maximum head reached, at high water, is 27 ft. The power house is of reinforced concrete, and has had installed in it two generating units, consisting of vertical-shaft turbines direct-connected to generators on the floor above. Each of the two shafts carries three turbine runners; the speed at 18 ft. head is 150 r.p.m. Each of the generators is a 900 k.w. three-phase, 60-cycle, 2,300-volt, revolving-field alternator. There is an exciter driven by a separate turbine, and another driven by an induction motor. The potential is stepped up by oil-filled, water-cooled transformers to 22,000 volts for the transmission line, which is 16.3 miles long, and which delivers the current to the pumping station at Coyote Rapids farther down the river.

The pumping station is of similar construction to the power station, and has room for four pumping units, two of which are at present installed. Like the generating units, these are vertical-shaft direct-connected, the induction motors being on the upper floor and the centrifugal pumps down below. Each motor is 450 horse-power, three-phase, 60-cycle, 2,200-volt, 175 r.p.m., the line potential being stepped down by transformers similar to those in the power station; half-voltage taps are provided for starting the motors.

Each pump is a single-stage, vertical-shaft, single-suction, enclosed-runner, centrifugal pump, designed for 62.5 sec-ft. capacity against a total head of 50 ft., with 30-in. suction connection and 30-in. discharge. The water from the two pumps enters a single delivery pipe of 66-ins. diameter, discharging into a cement-lined basin at the head of the main canal. The Allis-Chalmers Company, who built and installed the machinery and apparatus in these plants, guaranteed the pumps to have an efficiency of 65 per cent.

Utilization of the Power at Drops in Laterals.—The use of water-power for pumping is not, however, dependent upon the presence of big rivers and waterfalls where thousands of kilowatts run to waste. An extensive irrigation system may be run through a country in which the land is generally quite flat, but where, nevertheless, the topography is broken in some places; or it may be in a region abounding in steep places. In either case there will be points where the most direct location of canal or lateral will give a grade too steep for an earthen ditch, because of the erosion of the banks from the swiftly flowing water. This necessitates the use of drops. Sometimes a drop is in principle just like a timber or concrete dam; sometimes it is a conduit, open or closed, or merely a stream or waterfall down a rocky hillside; in any case there is a quantity of water falling a certain height in a reasonably short horizontal distance, constituting a water-power. With power going to waste in the system this way, and with areas of high land which could be irrigated by pumping, it is natural to study whether it will pay to make the necessary outlay and use the source to fill the need.

An example from actual practice will illustrate this kind of problem. Consider two drops in different laterals, situated a few miles apart; the former can be called A and the latter B. At drop A the water flows first through a wooden trough, then over the rocks where the surface soil has been eroded; total fall 75 ft. in a horizontal distance of 460 ft. At drop B there is four times as much water, but only about 21 ft. fall. Drop A is a natural one, drop B is entirely artificial, the deep excavation forming a channel which for a long distance has no outlets and lies much below the level of the surrounding country. There are thousands of acres of dry land in the vicinity, higher than the main canal, having good volcanic ash soil, and needing only water to become valuable agricultural land. The main canal carries plenty of water. Now having power, water and dry land, what can best be done.

* Abstracted from an article in the "Purdue Engineering Review" for 1911.

We get up a preliminary design consisting of the following elements: A hydro-electric power plant at drop A; an electrical transmission line from there to drop B; hydraulic power development at power B; pumps at drop B driven by the transmitted electric power and by the hydraulic turbine. On the way over the transmission line is tapped to supply power to a pumping plant for an isolated high tract.

The electric power plant to be located at the foot of drop A would contain a turbine direct-connected to a three-phase alternating current generator. Concrete headworks at the top of the drop and a steel penstock would be provided to convey the water to the turbine. A by-pass must also be provided to supply lands below the drop in case the turbine is shut off.

The current can be transmitted this distance without step-up transformers, making the generator potential 2,300 volts. At drop B we can utilize the current in an induction motor at the line potential.

Starting with the horse-power available from the drops, and figuring the thing out step by step, allowing for the various hydraulic, mechanical and electrical losses, we come to the problem of determining the proper combination of height of lift and quantity of water pumped to make use of the power to the best advantage. There are in the problem several varying elements, as follows:

(a) Area of land between any selected contour line and the canal from which the water will be pumped.

(b) Quantity of water which can be pumped by the given horse-power to any selected height of lift.

(c) Number of acres which can be irrigated by the given horse-power at a given rate of duty, for any selected lift.

(d) Number of acres which can be irrigated by any selected quantity at the given duty.

The writer has applied with very satisfactory results a graphical method of solution previously used in this class of problem by Mr. E. A. Moritz, C.E. Figure 1 is a diagram for the simplest possible case, viz., a single lift and single district irrigated. Taking the total brake horse-power available at the site of the pumping station, and allowing a certain percentage for losses in pumps and delivery line, we get, say 156 net horse-power in water pumped, equal quantity pumped, in second-feet, multiplied by height of lift in feet and divided by 8.8 practically.

From a topographical map of the land above the canal, we obtain the areas between the various contour lines (which may be selected for discharge elevations) and the canal, by measurement with a planimeter, and plot them as a curve in which the abscissae represent acres and the ordinates represent height of lift, or difference of elevation between outlet contour and main canal, on line of proposed discharge pipe. In this case the slope of the land averaged up so nearly uniform that the portion of the curve plotted is shown as a straight line, marked A.

Curve B is also plotted with reference to lift on the vertical scale, but its abscissas represent the quantity of water which can be pumped at various lifts, as obtained from the foregoing equation. It is obvious that the curve will be an equilateral hyperbola.

A third curve, marked C, is plotted with reference to lifts; it is derived from B by multiplying the quantity pumped at any lift by the duty, or number of acres per second foot, in this case assumed at 143. It will, therefore, also be a hyperbola and will show acres of abscissas.

Finally, the different values of "water pumped," as shown on the horizontal scale, are multiplied by the constant duty (143), giving number of acres corresponding to each quantity pumped, at the given duty, and the resulting straight line D is drawn, acres being in this case ordinates, since the abscissas have already been used for quantity of water.

A and C intersect at a lift of 60.5 ft., and an acreage, read on the horizontal scale, of 3,250. The corresponding quantity pumped is found by running horizontally along the 60.5 ft. level to curve B, as indicated by the dotted line, which intersects B at value 22.8 cu. ft. per second. If now the dotted line be followed vertically downward to intersection with line D, we read on the vertical scale the acreage irrigable by this quantity, 3,250 acres, checking with the value read at the first intersection and demonstrating the accuracy of the work.

This diagram may become quite complicated if plans for using two or more lifts be considered, necessitating

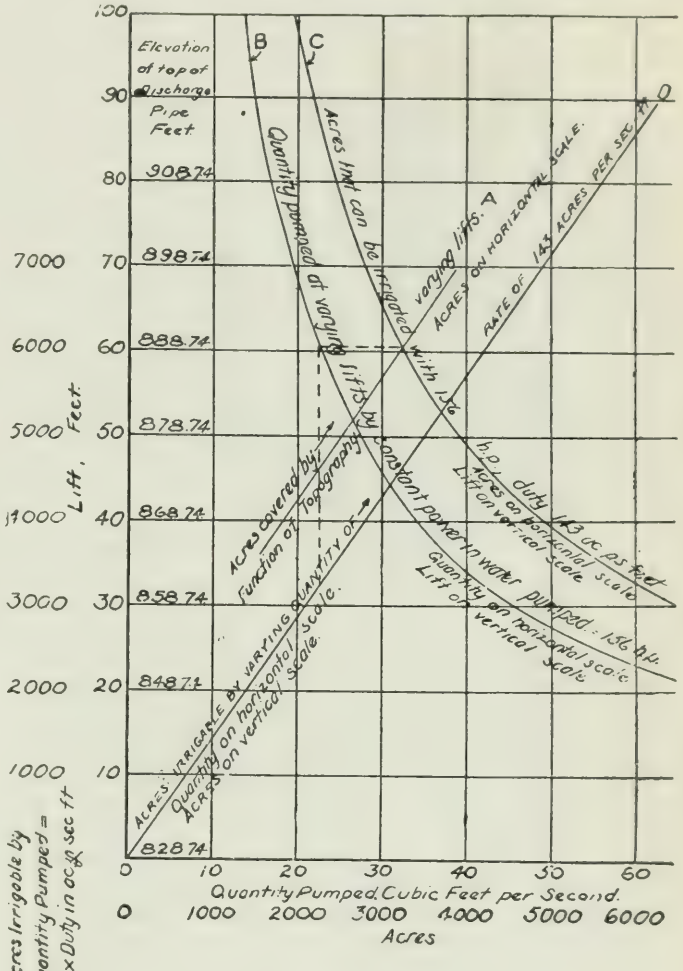

Elevation of top of Discharge Pipe Feet
90874
89874
88874
87874
86874
85874
84874
82874
B
C
D
Quantity pumped at varying lifts.
Acres that can be irrigated with 1.56 varying lifts.
Acres on horizontal scale.
Rate of 143 acres per sec. ft.
Acres covered by ---- lifts by Function of Topography
Constant power in water pumped = 156 H.P.
b.p. duty 143 cu. ft. per sec.
Acres on horizontal scale
Lift on vertical scale
Quantity on horizontal scale
Lift on vertical scale
Acres irrigable by varying quantity on horizontal scale
Acres on vertical scale
Lift, Feet
Quantity Pumped, Cubic Feet per Second.
Acres
Acres Irrigable by Quantity Pumped = 9 × Duty in cu. ft. per sec. ft.

Fig. 1.

division of the horse-power into units and plotting separate curves B and C for each unit; and if different values of water duty be considered, the number of curves C and D plotted will be multiplied by the number of duty values considered. In such a case one would use a color scheme. The principle is sufficiently illustrated by the simple case chosen, without going into such complications, and it is evident that a great deal of figuring can be saved as compared with a cut-and-dry method of solution.

Having ascertained from the diagram the height of lift, computations can be made as to quantity pumped per unit, proper sizes of pipe, etc., and the selection of types, sizes and speeds of motors, pumps and turbines best adapted to the work and to each other is made. Making general plans for the setting and housing of the machinery, and an esti-

mate of construction cost of the different plants with their machinery, the transmission line, pipe lines and water distribution systems, and dividing by the number of irrigable acres, will give the charge per acre for first cost; the estimated cost of operation is divided in like manner. Statistics as to crop values and net profits per acre from similar lands already under cultivation in the neighborhood, will permit a comparison of the cost of the proposed improvement with the ability of farmers to stand the cost.

A preliminary design made by the writer for a pumping plant operated by hydraulic and electric power, is shown by Fig. 2. In this design the aim was substantital construction, with small maintenance cost, together with convenience and accessibility. It provides for concrete headworks and flash-board supports on the main canal, the cross-section of which is reduced as it passes the branch canal, at the head

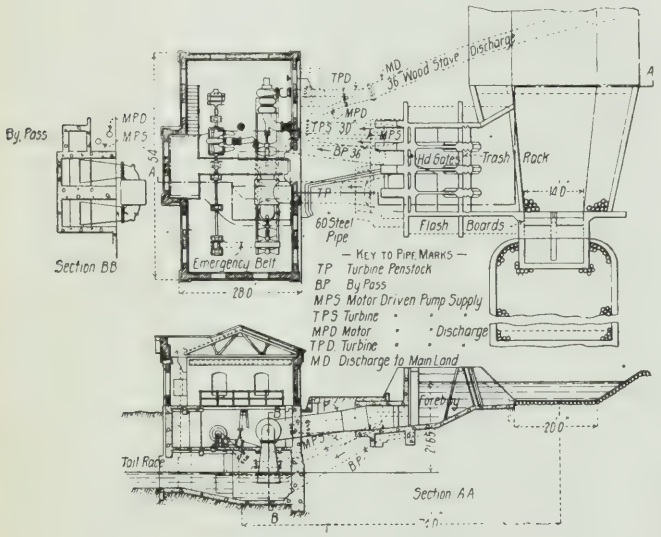


Fig. 2.

of which the plant could be located. The water goes through the trash racks, through the forebay (above which is to be carried a road which parallels the main canal), and through the head-gates to the various pipes. There are two gates supplying the turbine penstock; one gate supplying by-pass, feeding water to the branch canal if turbine is not discharging the necessary amount; and one gate supplying the pumps.

The turbine speed at the given head is so low as to require either very large pump impeller, or a multi-stage pump, to raise the water to the proper height. The motor-driven pump, however, can be a single-stage, because of the ample speed of the motor. Aside from other advantages, the centrifugal type of pump is particularly adapted to this service, because of the large amount of silt carried by the water in this canal.

In case of accident to the electric supply or apparatus, the turbine would be the sole motive power. The emergency belt connections shown makes it possible in such an event, to use either pump and shut off the other for repairs or other necessary attention. When not in use, the belt and shafting do not waste any power in friction as provisio is made for disconnecting them at the couplings.

As a considerable portion of the excavation at the site is already made, the excavation cost for this plant would not be as great as might appear from the drawing.

Greater compactness of the plant might be attained, at the sacrifice of certain features which it was desired to embody in this design. It should also be borne in mind that this does not represent a final, perfected design, but is merely a preliminary plan.

LABORATORY METHOD OF OBTAINING CORRECT PROPORTION OF PORTLAND CEMENT TO SAND OR STONE SCREENINGS FOR MORTAR.

That chemistry is a great help in matters pertaining to the manufacture of cement is a well-known fact, but that precise chemical methods may be used in concrete proportions is a fact not so generally known. The ideal or theoretically perfect concrete is that in which the best aggregates are scientifically proportioned and graded in size so as to reduce the percentage of voids to the minimum and give the greatest density. According to Mr. Albert Moyer, Asso. Am. Soc. C.E., who has spent considerable time in expedimental work along this line for the Vulcanite Portland Cement Company, Philadelphia, Pa., U.S.A., it is convenient to assume a weight of 94 pounds net (1 bag of Portland cement) to the cubic foot, and allow 2 42/64 oz. of cement to the 50 c.c.

The necessary equipment includes several graduated glass tubes of 200 or 250 cubic centimeters capacity and a balance that is sensitive to a sixty-fourth of an ounce (6 grains).

Weigh several samples of cement of 2 42/64 (50 c.c.) each. Measure several samples of sand from 87.5 to 150 c.c. each, so that proportions of cement to sand are secured thus, 1:1.75, 1:2, 1:2.25, 1:2.5, 1:2.75, 1:3.

The sand should be dried before measuring, which should be done accurately; pour the dry sand slowly into the measuring tube, jarring the same while pouring. Add the previously weighed cement sample to the sand, and then add sufficient water to make a mortar which, when tamped in the glass tube, will not cause any water to rise to the surface.

Place a little of this mortar at a time in the graduated glass tube (not over 4 c.c. at one time). Press the mortar down hard with a flat-end stick, leaving enough space for the expulsion of air between the walls of the tube and the stick. Pack the mortar as tightly as possible and note the space occupied by each sample. It will be found that the total volume of any one sample will exceed the space occupied by the sand alone.

The sample containing maximum density will be that which contains (in progression) the largest amount of sand but has not appreciably increased the volume of the mortar. As an example, supposing it to be found by this method that the sample containing proportions of 1:3 gave a volume of 110 c.c., 1:2.75 gave 110 c.c., 1:2.5 gave 110, and 1:2.25 gave 115 c.c. Then, the 1:2.5 is the sample which should theoretically give maximum density of the mortar. The 1:2.25 would be too rich, and the 1:3 too lean.

The cement having been weighed in each instance the unit of measurement for the cement being 94 lbs., 1 bag of cement assumed to be equivalent to 1 cu. ft., calculated on the actual volume of a barrel of cement as being 3.8 cu. ft. —the quantity of sand being measured and noted for each sample, you are thus in possession of the proportions required for a mortar for use in actual work. This refers entirely to concrete in which maximum density is required; such concrete will be almost impervious to water.

Having obtained the volume of mortar produced by each sample and the tensile strength of each sample, you can then determine as to whether a mortar of less density may with safety be used for work which does not require a water-tight concrete.

In the matter of screenings or quarry tailings for mortar, all of which will pass through a ¼-inch sieve and not containing over 10 per cent. of dust—that which would pass

through a 100 sieve—you may obtain the proportion of cement to screenings or quarry tailings which will produce maximum density, in the same manner, with the possible exception that a larger diameter graduated glass tube should be used on account of the shape of the particles of the quarry tailings.

By the method above described the relation of weight to volume is standard, these figures being based on 94 lbs. of cement as being equal to 1 cu. ft. Therefore, it makes no difference whatever if this be actual or not. Thus the variations in different brands of cement are automatically cared for, providing the same brand is used to determine the proportions for mortar as will be used in the actual work. These tests should be carried on with various sands, as there may be two or more sands obtainable in the same locality, one of which might require much less cement than the other and yet obtain maximum density in the mortar, effecting considerable economy on a large job.

THE ADHERENCE OF FLAT SURFACES.

A paper on the "Adherence of Flat Surfaces" was read before the Royal Society by Mr. H. M. Budgett, who remarked that in recent years it has been found possible to polish plane surfaces of hardened steel to a degree of accuracy which had previously been approached only in the finest optical work, and to produce steel blocks in the form of end gauges which can be made to adhere or "wring" together in combinations. These blocks will often cling together with such tenacity that a far greater force must be employed to separate them than would be required if the adhesion were solely due to atmospheric pressure, and the purpose of the paper was to examine the various causes which produce this adhesion.

The only previous experiments in this direction appeared, he said, to be those carried out with Whitworth surface plates by Professor Tyndall in 1875. By wringing together two of these plates and suspending them in a vacuum, he proved that the adherence between them was not caused solely by atmospheric pressure, as had been previously supposed. According to Goodeve, the conclusion at which Tyndall arrived was that the plates adhered by the molecular attraction of the bearing points brought into close contact by reason of the near approach to absolute truth of surface. Frequent references had been made to these experiments, and the conclusions of Tyndall appeared to have been generally accepted.

Liquid Films.—The author's curiosity was aroused by the fact that some steel gauges which he was constantly using in combinations did not always cling together with the same force. Frequently they refused to adhere to one another at all, whilst at other times considerable difficulty was experienced in getting them apart. On one occasion, when two blocks had been left wrung together for a long time, it was found necessary to hold one in a vice and hit the other sharply with a hammer in order to separate them. Subsequent examination showed that the faces had rusted together, which proved that some moisture must originally have been present between them. This led to the discovery that a minute film of condensed water vapor always formed upon the steel when the blocks were held with warm hands, and if care were taken to avoid this, and the faces were thoroughly cleaned with alcohol to remove grease, then all signs of adhesion vanished and the blocks would fall apart at once under their own weight. It soon became clear that the wringing effect was chiefly due to the presence of a liquid film between the blocks, and it was decided to make a series of experiments in order to examine the adhesive properties of various liquid films, the effects of atmospheric pressure, and the force of attraction between the molecules of steel in the two surfaces.

A number of hardened steel blocks were specially made in the form of cylinders 1 in. in diameter and ½ in. deep, having a central screwed hole 5/16 in. in diameter, the area of the faces being thus 0.7 sq. in. These were specially polished with great care so that their faces were true planes within one-millionth of an inch, the accuracy being optically tested by means of proof glasses. Many hundreds of readings were taken with dozen of pairs of blocks, and the average and maximum results were given in the following table:

Liquid.	Pull in lb. at separation.	
	Average.	Maximum.
Condensed water vapor	35	65
Turpentine	29	39
Paraffin	27	46
Oil of almonds	24	35
Lubricating oil (Price's)	22	30
Olive oil	20	33
Sperm oil	18	32
Rangoon oil (Price's)	17	28

Considerable variation in the readings was unavoidable, as it was impossible to gauge exactly the thickness and uniformity of the applied films, and there was an element of uncertainty in the action of sliding the blocks together. No adhesion could be obtained with volatile liquids such as alcohol, benzine, and petrol, and viscous liquids such as glycerine, treacle, and glucose produced very little effect.

Atmospheric Pressure.—In order to determine what were the effects of atmospheric pressure, arrangements were made by which, after being wrung together, the blocks could be separated in a vacuum. It was surprising to note that the force due to atmospheric pressure in no case exceeded 5 lb., as, the area of the faces being 0.7 sq. in., it might have been expected that this force would have approached 10.5 lb. It might naturally be supposed that such accurate surfaces, with a grease film between them, would be perfectly air-tight. It was evident, however, that air must have free access to a very large area of the faces, probably owing to the blocks being pulled apart or distorted slightly under the strain of the applied force, the film between them stretching before breakage occurred. It must be remembered that the volume required to fill the space between the faces was exceedingly minute, and since the pull was increased very gradually, a considerable time was allowed for the air to leak in or out. With thicker films the atmospheric pressure had a greater effect. Thus, with a fairly thick layer of Rangoon oil a difference of 6.5 lb. was noted between the force of separation in air and in vacuo, the force due to the air in this case being 9.3 lb. per sq. in. This might be due to the air being more impeded by the thick oil, or to the faces being less distorted, or separated, owing to a smaller force being required to cause breakage when a thick film was present. On the other hand, when the faces were perfectly clean and no film whatever was present, the adhesion almost vanished and the blocks would not support each other although their weight was only 1½ oz., showing that in this case the force due to atmospheric pressure was almost eliminated. For the same reason it was obvious that the force due to the attraction of the molecules of steel in the opposing faces was quite negligible in comparison with those under consideration.

The author concluded that at least 75 per cent. of the adhesion was caused by the presence of a liquid film between the faces in contact, and that not more than 25 per cent. was due to atmospheric pressure.

Metallurgical Comment

T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

PRODUCTION OF IRON AND STEEL IN CANADA.*

The iron and steel industry in Canada has had a fairly steady and continued development during the past few years. The serious depression under which this industry suffered in the United States in 1908 had comparatively little effect in Canada although there was a general falling off in output during the year. The production of 1909, however, greatly exceeded that of 1907, while the year 1910 again shows a very substantial increase in the production of pig iron and steel over the year 1909. The actual shipments of iron ore, however, from Canadian mines in 1910, were less than in 1909, although greater than the 1908 shipments.

The total shipments of iron ore from mines in Canada in 1910 were 259,418 short tons; there were used in blast furnaces 1,548,226 tons of iron ore, and in steel furnaces 39,332 tons; 800,797 tons pig iron were made, a large part of which was used directly in the manufacture of steel, and a total of 822,284 tons steel ingots and castings were made.

The development of iron ore mining in Canada has not kept pace with the growth of the metallurgical industry in iron and steel. The rate of production of iron ore has shown practically no increase during the past ten years, while the production of pig iron during the same period has increased nearly eight fold.

About 11 per cent., only, of the iron ore used in Canadian blast furnaces during 1910, was of domestic origin; of the coke used 49 per cent. was either imported or made from imported coal, and 18 per cent. of the limestone flux used was from sources outside of Canada. It is evident that this industry is now to a very large extent dependent upon imported raw materials.

The assistance granted by the Federal Government to the iron and steel industries in the form of bounties, ceased on December 31, 1910, with the exception of the bounty on steel rods, which was continued to June 30, 1911.

The accompanying table gives a summary of the chief statistics of production of iron ore, pig iron, and steel, while more detailed records will be found in subsequent pages:

Summary of Iron and Steel Statistics 1908, 1909, and 1910.

	1908. Tons.	1909. Tons.	1910. Tons.
Iron ore shipped	238,082	268,043	259,418
Canadian iron ore charged to blast furnaces	209,266	257,502	171,191
Imported iron ore charged to blast furnaces	1,051,445	1,235,000	1,377,035
Iron ore charged to steel furnaces	(a)	(a)	39,332
Pig iron made	630,835	757,162	800,797
Pig iron imported	58,365	148,338	243,859
Pig iron exported	290	5,063	9,763
Pig iron consumption (calculated)	688,910	900,437	1,034,893
Pig iron used in steel furnaces	(a)	(a)	690,913
Steel ingots and castings made	588,763	754,719	822,284
Steel rails made	267,192	377,642	399,762
Canadian coke used in iron blast furnaces	492,076	412,016	491,281
Imported coke used in iron blast furnaces	325,670	507,255	476,838
Iron and steel imported..(b)	1,079,000	565,740	979,939
Number of completed blast furnaces ..... No.	16	16	17
Number of men employed in blast furnaces ..... No.	1,380	1,486	1,403
Wages p'd in blast furnaces $	750,224	879,429	1,006,727
Value of pig iron produced $	8,111,194	9,581,864	11,245,622
Value of iron and steel goods exported ..... (c) $	5,907,792	7,172,413	7,895,489
Value of iron and steel goods imported ..... (d) $	61,819,698	40,393,431	59,952,197

(a) Not collected.

(b) Figures cover the fiscal year ending March 31 and include all iron and steel goods for which weights are given.

(c) Figures cover the calendar year.

(d) Figures cover the fiscal year ending March 31.

IRON ORE.

The total shipments of iron ore from mines in Canada in 1910 were 259,418 tons valued at $574,362 at the shipment point, as compared with 268,043 tons valued at $659,316 in 1909, and 238,082 tons valued at $568,189 in 1908. Of the 1910 production 130,380 tons are classed as hematite, 127,768 as magnetite, and 1,270 tons as bog ore. Ontario is the largest producer, having shipped 231,445 tons or nearly 90 per cent. of the total production. New Brunswick enters the list of producers with shipments of 5,336 tons from the mines near Bathurst. In Nova Scotia 18,134 tons were shipped from the Torbrook mines and in Quebec province, in addition to the bog ores, a small tonnage (3,233 tons) of titaniferous iron sands was shipped from the north shore of the St. Lawrence. Although no production of iron ore is credited to British Columbia, a shipment of a small barge load of copper was made from the Raven mine, Texada island, to Seattle, Wash.

The production by provinces during the past three years was as follows:—

Production of Iron Ore by Provinces, 1908-9-10.

Provinces.	1908. Tons.	1908. Value. $	1909. Tons.	1909. Value. $	1910. Tons.	1910. Value. $
New Bruns'k	.....	.....	.....	.....	5,336	11,910
Nova Scot'a.	11,802	17,620	.....	.....	18,134	40,478
Quebec	10,103	22,094	4,150	5,508	4,503	8,252
Ontario	216,177	528,475	263,893	653,808	231,445	513,722
British Colm.	.....	.....	.....	.....	.....	.....
	238,082	568,189	268,043	659,316	259,418	574,362

The production during 1909 and 1910 classed as magnetites (including titaniferous iron sands and some ores with an admixture of hematite), hematites (including brown ores), and bog ores, was as follows:—

Classified Production of Iron Ore, 1909-10.

Character of ore.	1909. Short Tons.	1909. Value. $	1909. Per Ton. $ c.	1910. Short Tons.	1910. Value. $	1910. Per Ton. $ c.
Magnetite	74,240	162,280	2 19	127,768	289,876	2 27
Hematite	190,473	492,348	2 58	130,380	281,090	2 16
Bog	3,330	4,688	1 41	1,270	3,402	2 68
	268,043	659,316	2 46	259,418	574,362	2 21

* Abstracted from Govt. Report.

Nova Scotia.—The Torbrook mines were the only shippers during 1910, the quantity shipped being 18,134 tons in three cargoes to Philadelphia, Pa., Glasgow, Scotland, and Middlesborough, England, respectively. The ore is a hematite and the shipments averaged about 48 per cent. metallic iron. The total quantity of ore mined during the year was 53,054 tons, a large part of which was in the stock piles at the mines at the close of the year.

Some development work was done at Arisaig, Antigonish county, by the Arisaig Iron Company, but no ore was shipped.

The blast furnaces at Sydney and North Sydney receive their ore supplies from Newfoundland chiefly. The two Canadian companies operating at Wabana, shipped during the year 1,259,626 short tons of hematite ore averaging fro n 50 to 52 per cent. iron; of which 808,762 tons were shipped to Sydney and 450,864 tons to the United States and Europe.

New Brunswick.—Shipments were made from the mines at Austin Brook, near Bathurst, to the extent of 5,336 tons, the ore being sent to Philadelphia. The ore is a magnetite with an intermixture of hematite, and the properties are being developed by the Canada Iron Corporation. About 25,515 tons of ore were mined during the year. Shipments are made from the company's docks at Newcastle, at which there was a considerable tonnage in stock at the close of the year.

Quebec.—The iron ore production in Quebec in 1910 included 1,270 tons of bog ore shipped to Drummondville, and 3,233 tons of titaniferous magnetic sands shipped from St. Urbain, Champlain county, to the United States. In 1909 the shipments were 3,330 tons of bog ores and about 820 tons of titaniferous iron sands.

These titaniferous sands have been shipped largely for experimental purposes and a nominal value of $1.50 per ton has been placed upon the production, although the actual cost of placing the ore on board vessels was possibly several times this amount.

Ontario.—Shipments were made by four mines in this province during the year, viz.: the Mayo, at Bessemer, Hastings county; the Moose Mountain, at Sellwood, 30 miles north of Sudbury; the Helen, north of Michipicoten, and the Atikokan, 130 miles northwest of Port Arthur, on the Canadian Northern Railway. In addition to these a considerable tonnage of ore was reported as having been raised at the Wilbur mine in Lanark county, but no shipments were made.

The total shipments of ore during the year were 231,445 tons, valued at $513,722; as compared with shipments of 263,893 tons, valued at $653,808, in 1909.

British Columbia.—No regular shipments of iron ore were reported from the province. Some prospecting work was done on the Raven mine on Texada island, and a small scow load of cupiferous iron ore shipped to Seattle, Wash., for experimental purposes.

Following is a list of the principal producers of iron ore in Canada:—

Canada Iron Corporation, Limited, Mark Fisher Bldg., Montreal.

E. H. Duval, Levis, Que. (Guay P. O.).

H. C. Bosse, 92 St. Peter St., Quebec, Que.

Joseph Bouchard, Baie St. Paul, Que.

The Canadian Iron Ore Co., 1231 St. Valier St., Quebec, Que.

Exploration Syndicate of Ontario, Limited, Wilbur, Ont.

The Lake Superior Power Company, Sault Ste. Marie, Ont.

Atikokan Iron Company, Port Arthur, Ont.

Moose Mountain, Limited, Sellwood, Ont.

Dominion Bessemer Ore Company, Limited, 472 Bullitt Bldg., Philadelphia, Pa.

Pig Iron and Steel.—An increase is shown in the production of pig iron in Canada in 1910 over the production of 1909, as compared with an increase of 20 per cent. in 1909 over that of 1908.

At the close of the year Canada had seventeen completed furnaces and two under construction, grouped in ten separate plants and operated by eight separate companies or corporations.

The Londonderry furnace was not in operation during either of the past two years. These figures do not include the output from electric furnaces making ferro-products which are situated at Welland and Sault Ste. Marie, Ont., and Buckingham, Que. Ferro-silicon was made at Welland during 1910, but the Sault Ste. Marie and Buckingham plants were not in operation during the year.

Of the total output of pig iron in 1910, 17,164 tons, valued at $333,956 or $19.78 per short ton, were made with charcoal as fuel, and 783,633 tons, valued at $10,911,674 or $13.92 per ton, with coke.

The classification of the production in 1910 according to the purpose for which it was intended was as follows:—

Bessemer 219,492 tons, basic 425,400 tons, foundry (including miscellaneous) 138,741 tons.

The total production of pig iron in 1910 and 1909 is shown by provinces in the following table, the average value per ton being also indicated. In the case of Nova Scotia a large proportion of the pig iron is directly converted to steel, and as a very small portion of the metal is sold as pig iron it is somewhat difficult to place a satisfactory valuation upon the output. For statistical purposes a value of $12 per short ton has been placed upon this production in 1910. The Quebec production is entirely charcoal iron, which has for many years commanded a high price.

Production of Pig Iron by Provinces, 1909-10.

Provinces.	1909. Tons.	1909. Value. $	1909. Value per ton. $	1910. Tons.	1910. Value. $	1910. Value per ton. $	Percentage increase or decrease in quantity. %
Nova Scotia	345,380	3,453,800	10.00	350,287	4,203,444	12.00	+ 1.4
Quebec	4,770	125,623	26.34	3,237	85,255	26.34	—32.1
Ontario	407,012	6,002,441	14.75	447,273	6,956,923	15.55	+ 9.9
Total	757,162	9,581,864	12.65	800,797	11,245,622	14.04	+ 5.8

Of seventeen completed furnaces, six were in blast in 1910, for varying periods of time. The operating companies, with numbers and capacities of furnaces, were as follows:—

Dominion Iron & Steel Company, Sydney, C.B., one of the constituent companies of the Dominion Steel Corporation, Ltd.: four completed furnaces of 280 tons capacity each per day, operated throughout 1910, two for 365, one for 112 days, and the fourth for 255 days. A fifth furnace has been completed and will go into blast early in 1911, while the erection of a sixth furnace has been arranged for, the completion of which will give this company a capacity of over 400,000 tons per annum.

Nova Scotia Steel and Coal Company, Limited, New Glasgow, N.S.: one furnace at Sydney Mines, C.B., of 200 tons capacity, operated 311 days. Furnace was blown out on May 1, when, according to the report of the general manager, a new crucible jacket of 2½-inch plate, steel reinforced with cast-iron, water-cooled slabs 4½ inches thick, dovetailed into each other, new bosh jacket and mantel were installed; the furnace lined throughout, hot blast stoves, downcomers, gas-mains, boilers, blowing engines, and pumps were all overhauled and renewed where necessary. The furnace again went into blast June 24, and from this date to December 31, made an average daily output of 243 tons. For the same

period, previous to relining, the average daily output was 160 tons.

Londonderry Iron & Mining Company, Limited, Londonderry, N.S.: one furnace of 100 tons capacity; idle throughout the year.

Canada Iron Corporation, Limited, Montreal, Que.: two small furnaces of seven and eight tons capacity, at Drummondville, Que., operated 272 days; one furnace of 25 tons daily capacity, at Radnor Forges, Que., operated 41 days during 1910; two furnaces of 125 tons and 250 tons at Midland, Ont., operated for 7 months and 4 months respectively.

Standard Chemical Company of Toronto, Deseronto, Ont.: one furnace with a daily capacity of 50 tons, operated for 253 days, during 1910.

Hamilton Steel & Iron Company (now the Steel Company of Canada, Ltd.), Hamilton, Ont.: two furnaces, one of 200 tons capacity, operated throughout 1910, a second furnace of 300 tons capacity, operated 329 days in 1910.

Algoma Steel Company, Limited, Sault Ste. Marie, Ont., a constituent Company of the Lake Superior Corporation: two furnaces at Steelton, near Sault Ste. Marie, of 250 tons capacity each, operated throughout the year. This company also has under construction a 400-ton furnace, a 12-inch and 18-inch merchant mill, and a complete installation of by-product coking ovens (110 ovens, Koppers type, with capacity of 1,100 tons of coke per day).

The Atikokan Iron Company, Limited, Port Arthur, Ont.: one furnace of 100 tons capacity, operated for 8 months during 1910.

Ferro-silicon, ferro-chrome, ferro-phosphorus, etc., have been made in electric furnaces at Buckingham, Que., by the Electric Reduction Company, Limited; the furnaces, however, were not in operation during 1910. Ferro-silicon has also been made in electric furnaces at Saulte Ste. Marie, and at Welland, Ont. The electric furnaces operated by the Electric Metals Company were in operation during 1910. These furnaces, constructed some three years ago, consist of four furnaces of from 1,000 to 1,500 horse-power each, the daily production being from 5 to 8 tons.

The imports of ferro-silicon, manganese, etc., during the calendar year 1910, were 18,900 tons values at $464,741, or an average of $24.59 per ton. The imports during the calendar year 1910 were 17,699 tons valued at $411,536, an average of $23.25 per ton.

Returns of steel production received direct from the producers showed a total production of ingots and castings for 1910 of 822,284 tons, as compared with 754,719 tons in 1909, and 588,763 tons in 1908. In 1910 the production of open-hearth ingots was reported as 586,932 tons, Bessemer ingots 222,668 tons; direct open-hearth castings 18,085 tons, and other steels 599 tons; compared with 1909 there was an increase in total production of 67,565 tons, or nearly 9 per cent.

Following is a list of firms making steel in Canada:—

Dominion Iron and Steel Company, Sydney, N.S.
Nova Scotia Steel and Coal Company, New Glasgow, N.S.
Montreal Steel Works, Limited, Montreal, Que.
The Algoma Steel Company, Sault Ste. Marie, Ont.
The Hamilton Steel and Iron Company, Hamilton, Ont.
The Wm. Kennedy Sons, Limited, Owen Sound, Ont.
The Ottawa Steel Castings Company, Limited, Ottawa, Ont.
The Ontario Iron and Steel Company, Limited, Welland, Ont.

The production of finished rolled iron and steel in Canada from 1906 to 1910, as ascertained and published by the American Iron and Steel Association, was as follows, in long tons:—

Annual Production of Rolled Iron and Steel, 1906-10.

Products—Gross tons.	1906.	1907.	1908.	1909.	1910.
Rails	312,877	311,461	268,692	344,830	366,465
Structural shapes and wire rods	48,351	65,541	41,520	74,136	80,993
Plates and sheets	15,202	18,493	11,656	36,241	26,642
Nail plate, merchant bars and all other finished rolled forms	195,312	204,684	174,649	207,534	265,711
Total	571,742	600,179	496,517	622,741	739,811

ELECTRIC STEEL EXPERIMENTS.

A German steel company carried out a few experiments on a 3-ton Girod furnace preparatory to equipping their plant with electric furnaces. That connections to such a furnace can play such an important part in the life of the lining and the power consumption of it is well emphasized in the changes made by the author in question on his furnace. Where one connection was made to the top electrode and another to the bottom electrode it was found that the arc was thrown strongly against the opposite side of the furnace to the conductors. The top conductor was then split into two and led to the electrode on opposite sides, a single conductor being used on the bottom electrode. With this system the arc was blown toward the line. The final solution of the problem was to split both the conductors, bring them up to the furnace many feet underneath and then rise vertically, a pair on each side of the furnace, carrying the conductors leading to the top and bottom electrodes just as far as possible side by side. To increase this length the bottom electrodes were in electrical connection with the shell of the furnace so that connection with them could be made high up on the side of the furnace. The splitting of the conductors keeps the arc central and saves half the lining and all trouble with blowing out of the arc. Even the shell of the furnace was finally made of steel of low permeability. The energy saving in the conductor system and shell as revised amounted to 10 per cent. over the first installation. The flat circular arc now carried on the furnace means an even greater saving of electrode, as previously when it was thrown off to one side it caused very uneven consumption and consequent waste of electrode.

The present system of working is to charge the furnace with about three tons of open-hearth metal and put on a current of 4,000 to 6,000 amperes. A highly oxidizing slag is formed, and all the phosphorus and some of the sulphur is removed during this oxidizing period. The bath is then deoxidized under a new slag formed of lime, sand, ferro-silicon and petroleum coke or scrap electrode ends. This removes sulphur down to 0.01 per cent. On an average five charges are worked in 12 hours, though this is dependent on the amount of impurities to be removed.

With the original form of two conductor connections where the arc was thrown to one side, the silica roof over that side even with air cooling, lasted only 20 heats. With the four-conductor system the roof now lasts 60 to 70 charges. Experiments are not yet completed as to the economy of using other materials in place of silica for the roof.

The side walls were first formed by ramming a mixture of magnesia and tar around a core shaped like the inverted frustrum of a pyramid. Such a lining cost £36. It was later determined that dolomite would most economically replace the magnesia, so all linings are now made of this material. They last 120 charges and cost £17. The total cost of lining, including repairs to slag line between heats, amounts to 1s.

3d. per ton of steel. The area of the ends of steel electrodes in the bottom bears the ratio of 0.05 to 80 to that of the whole bottom.

The bottom electrodes are water-cooled in the ends projecting outside of the furnace. The dolomite bottom is rammed in between them with an air tamper, such a bottom lasting 1,000 heats in a furnace run very intermittently. A calorimetric determination of the heat carried out in the cooling water of these bottom electrodes gave 10.1-kw.-hours for the 130-minute run, or about 1.01 per cent. of the total electrical energy supplied, or 2.9-kw.-hours per ton of steel produced. The cooling water used in the top electrode carried out 36.7-kw.-hours, 3.65 per cent. of total energy supplied, or 10.5-kw.-hours per ton of steel.

The running of this small experimental furnace has thrown much light on the nature of many reactions in the refining of the steel. In the oxidation period carbon is but slowly removed, manganese more rapidly, phosphorus very rapidly, and about 20 to 35 per cent. of the sulphur. The sulphur appears to be removed in three ways: In the oxidation period by the action of the iron oxide in the slags; in the deoxidation period by solution in the high lime slags; and volatized as silicon sulphide. It has also been noted that oxides, slag emulsions, and gases have a much more important bearing on the physical properties of the finished metal than the sulphur and phosphorus present.

NEW YEAR'S HONORS FOR CANADIANS.

The following Canadians were honored by King George on New Year's Day:—

Premier R. L. Borden—Privy Councillor.

Lieutenant-Governor J. M. Gibson—K.C.M.G.

Joseph Pope, undersecretary for external affairs—K.C.M.G.

Thomas Cooper Boville, deputy-minister of finance—C.M.G.

Rudolphe Forget—K.B.

E. B. Osler—K.B.

Charles Slemin, Brantford's chief of police—King's medal.

THE ELECTRICAL DEPARTMENT OF LONDON, ONT.

The financial statement of the electrical department of London, Ont., shows that buildings and land cost $21,000; plant equipment, $44,000; distribution system and municipal street lighting, $193,000, which, with other expenditures on capital account amounted to $350,000. The statement of revenue and expense is the most interesting, as there had been some doubt as to whether there might not be a deficit the first year. The total receipts were $78,892.16, including street lighting and other municipal business. The expense for power and operation was $55,692.07, leaving a gross revenue of $23,200.09. Out of this the sum of $16,807.93 has to be taken, this being the amount estimated by the City Council as necessary to cover interest and sinking fund charges on debentures for distribution system, leaving a net surplus of $6,392.16. Included in the expense account is an item of $7,477.98 for the promotion of business. While some municipalities are allowing five years to pay this, London decided upon four and $6,000 was to have been carried forward to be written off in the future, but on account of the excellent showing made already it was decided to write off the full amount this year. Had this $6,000 been added to the assets, the total surplus would have been $12,392.16.

PERSONALS.

Mr. Thomas Graham, of Nanaimo, B.C., has been appointed to the position of chief inspector of metalliferous ores and coal mines.

Mr. C. B. Smith, of the firm of Smith, Kerry and Chace, is back in Toronto again, after a prolonged absence in the West.

Hon. William Harty, president of the Kingston Locomotive Company, has resigned his position. Mr. Æmilius Jarvis, of Toronto, will succeed him.

Mr. R. H. Murray, who has been with Mr. T. Aird Murray, consulting engineer, of Toronto, is leaving on a two months' trip to Scotland and England.

Mr. Hugh Jackson, treasurer of the Positive Clutch & Pulley Co., has resigned his position ao accept the cashiership of The Canadian Fairbanks-Morse Co., Limited, at Calgary, Alta.

Mr. J. P. Hynes, of Toronto, is named as the successor of Senator Frost to the position vacated on ahe Ottawa Improvement Commission. Mr. Hynes is greatly favored by Ottawa architects and other technical gentlemen, while in Toronto a strong effort is being made to secure his appointment.

Mr. Noble, who was employed by The Canadian Fairbanks-Morse Co., Limited, previous to his entering the organization of the Positive Clutch & Pulley Co., Toronto, last June has accepted a position under Mr. Patton, and now has charge of the transmission department of The Canadian Fairbanks-Morse Co., Limited, at Toronto.

Mr. Adolph Butze and Mr. J. R. Nutter have resigned their positions on the staff of the Grand Trunk Railway. Mr. Butze had an eventful career before joining the Grand Trunk. He served with Sherman through the Civil War. Later he was with the Wabash, Missouri Pacific, and Monon Route roads. He is succeeded by Mr. J. H. Guess, who joined the Grand Trunk last February as assistant to Mr. Butze. Mr. J. R. Nutter, who retires from the position of chief clerk to superintendent of eastern division, entered the G.T.R. service November 1st, 1883, as a porter, and subsequently served as clerk in assistant superintendent's office at Richmond, Que., and timekeeper at Montreal, received the appointment he retires from, October, 1897.

OBITUARY.

The death is reported of Prof. Leigh R. Gregor, who, for almost twenty years, has been connected with the McGill University as professor of languages, on January 1st, 1912.

Prof. Gregor was born in Charlottetown, P.E.I., fifty-two years ago, and was educated in the Prince of Wales' College, Charlottetown. He came to McGill in 1878 and entered the Arts course, graduating as B.A., in 1882. Having made a specialty of languages during his studies, he was appointed instructor of modern languages at the McGill High School shortly after he had graduated. In 1892 he was appointed lecturer in German at McGill, and in 1906 was promoted to the rank of associate professor of Modern Languages. He also had the degree of Ph.D. of Heidelberg conferred upon him.

CANADIAN NATIONAL ASSOCIATION OF BUILDERS' EXCHANGE.

City.	Secretary and Address.
Montreal—	J. H. Lauer, Sec., 263 St, James Street.
Toronto—	P. L. Fraser, Sec., 2 Berti Street.
Quebec—	A. Cote, Sec., 23 Rue St. Jean.

Ottawa—W. Hastings, Sec., 22 Metcalf Street.
London—Geo. S. Gould, Sec., Bank of Nova Scotia, Building.
St. Thomas—E. O. Penwarden, Sec., Dowler Block.
Kingston—E. R. Beckwith, C.E., 292 Earl Street.
Guelph—Mahoney Brothers.
Sault Ste. Marie—MacPhail & Wright Cons. Co., Ltd., P.O. Box 835.
Brantford—A. J. Cromar, Sec., 103½ Dalhousie St., P.O. Box 212.
Windsor—J. L. Young, Sec., 44 Campbell Avenue.
Hamilton—B. F. Richardson, Sec., The Building & Contracting Assoc., 60 Market Street.
St. John, N.B.—H. L. McGowan, 137 Princess Street.
Halifax, N.S.—H. Roper, care S. M. Brookfield, Ltd., 58 Grandille Street.
Winnipeg, Man.—J. H. Buxton, Jr., Sec., Portage Avenue and Hargrave Street.
Regina, Sask.—H. R. Abbott, Sec., Builders' Exchange.
Calgary, Alta.—A. Chamberlain, Sec., Board of Trade Bldg.
Edmonton, Alta.—A. O. Wetmore, Sec., McDougall Court.
Medicine Hat, Alta.—J. D. Everard Sec., Builders' Exchange.
Lethbridge, Alta.—E. Power, Sec., Acadia Block.
Vancouver, B.C.—Builders' Exchange, 342 Pender Street.
Victoria, B.C.—Chancery Chambers.

COMING MEETINGS.

THE AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—January 16th, 1912, Annual Meeting, Aldine Club, Fifth Avenue and 23rd Street, New York City, at 8 p.m. Secretary, Eugene W. Stern, 103 Park Ave., New York.

THE CLEVELAND ENGINEERING SOCIETY.—January 23, 1912. Special Meeting, Chamber of Commerce Bldg., Cleveland, O. R. C. Beardsley, Hydraulic Engineer, will present an illustrated paper on "The Design and Construction of Dams," with special reference to recent failures. Secretary, F. W. Ballard.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Jan. 24, 25, 26, 1912, General meeting, 413 Dorchester St. West, Montreal. Prof. C. H. McLeod, Secretary.

CANADIAN FORESTRY ASSOCIATION.—February 7th and 8th, 1912. Forestry Convention Meetings held in the Railway Committee Room, Parliament Buildings, Ottawa. Secretary, Mr. James Lawler, Canadian Bldg., Ottawa.

CANADIAN LUMBERMEN'S ASSOCIATION.—February 6, 7 and 8, 1912. Annual Meeting to be held at the same time and place as the Canadian Forestry Association.

CANADIAN NATIONAL ASSOCIATION OF BUILDERS.—The Sixth Annual Convention will be held in Toronto, February 20, 1912.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain, Acting Secretary; E. A. James, 57 Adelaide Street East, Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King's Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secretary, Mr. Heal, Moose Jaw

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Charles Kelly, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto. Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary. H. Mortimer-Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, T. A. Starkey, M.B., D.P.H., Montreal. Secretary, F. C. Douglas, M.D., D.P.H., 51 Park Avenue, Montreal.

CANADIAN RAILWAY CLUB.—President, H. H. Vaughan; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary, R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Alfred T. de Lury, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page
Medicine Hat, Alta., church	Jan. 20.	Dec. 28.	59
Ottawa, Ont., iron posts	Jan. 31.	Dec. 21.	68
Ottawa, Ont., supplying timber.	Jan. 15.	Jan. 4.	59
Ottawa, Ont., Indian supplies.	Jan. 15.	Jan. 4.	59
Ottawa, Ont., rails and rail fastenings	Jan. 10.	Dec. 28.	68
Ottawa, Ont., breakwater, Devil's Island, N.S.	Jan. 11.	Dec. 28.	59
Ottawa, Ont., wharf, Anse Aux Canards, Que.	Jan. 15.	Jan. 4.	59
Ottawa, Ont., wharf, New Liskeard, Ont.	Jan. 10.	Jan. 4.	59
Toronto, Ont., sewers	Jan. 16.	Dec. 28.	70
Toronto, Ont., main drainage works	Jan. 16.	Jan. 4.	70
Walkerton, Ont., bridge, Saugeen River	Jan. 23.	Jan. 4.	59
Woodstock, Ont., church	Jan. 15.	Dec. 21.	59
Winnipeg, Man., drawings for government buildings		Dec. 21.	68
Winnipeg, Man., motor generator set	Jan. 22.	Dec. 21.	59

TENDERS.

Arcola, Sask.—Tenders will be received until January 15th, 1912, for the erection of an addition to school building at Arcola, Sask. Plans and specifications may be seen at the office of Storey and Van Egmond, Architects, Regina, Sask., or from Jas. R. Donaldson, Sec.-Treas. Arcola S.D. 37, Arcola.

Dauphin, Man.—Tenders addresed to the town clerk, Canora, Sask., will be received until January 17th, 1912, for the erection and completion of a solid brick town hall building for the town of Canora, Sask. Plans, etc., may be seen at the office of the town clerk, Canora, or at the office of J. H. Bossons, architect, Dauphin, Man.

Ottawa, Ont.—Tenders will be received until January 16th, 1912, for the construction of a breakwater at Rimouski, Que. Plans, etc., may be seen at the offices of the District Engineers at Quebec, Montreal, and on application to the postmaster at Rimouski, Que. R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Ottawa, Ont.—Separate tenders addressed to the Minister of Marine and Fisheries, will be received until noon of February 26th, 1912, for the following:—1. The construction of one or two steel single screw bucket dredges, to be delivered at Sorel. 2. The construction of a steel single screw hopper barge, to be delivered at Sorel. 3. The construction of one set of compound steam engines to develop 450 indicated horsepower for dredge No. 37, to be delivered at Sorel. 4. The furnishing of fifty steel rock digging buckets, cast steel links and manganese bucket pins, to be delivered at Sorel. Full information and specifications can be obtained on application to the Purchasing and Contracting Agent, Department of Marine and Fisheries, Ottawa. Alexander Johnston, Deputy Minister of Marine and Fisheries, Ottawa.

Ottawa, Ont.—The time for receiving tenders for the construction of a jetty at the mouth of the Fraser River at Steveston, B.C., has been extended to Friday, January 19, 1912. R. C. Desrochers, Secretary Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until January 24th, 1912, for an Armory at Fernie, B.C. Plans, specifications, and form of contract can be seen and forms of tender obtained on application to the Caretaker of Dominion Public Buildings, Fernie, B.C.; at the office of Mr. Wm. Henderson, resident architect, Victoria, B.C., and at the office of R. C. Desrochers, Secretary Department of Public Works, Ottawa.

Toronto, Ont.—Tenders will be received until January 16th, 1912, by the Board of Control, for the construction of sewers on Hocken Avenue and Ellsworth Avenue, from Vaughan Road to Bracondale Avenue. G. R. Geary, Mayor, Chairman Board of Control, City Hall, Toronto.

Toronto, Ont.—Tenders will be received by the Board of Control until January 16th, 1912, for the supply of lead for 1912. Specifications at the office of the City Engineer. G. R. Geary, Chairman Board of Control, City Hall, Toronto.

Victoria, B.C.—Tenders for the erection of a six-story reinforced concrete building, for Messrs. C. Hayward and F. Barnard, will be received until January 15th, 1912. Bresemann & Durfee, Architects, Sayward Bldg., Victoria.

CONTRACTS AWARDED.

Fort William, Ont.—Tenders for the structural steel work for the four main buildings of the contemplated tube mills have been called for, and will be opened January 15th. All the other work in connection with the structures will be let to local contractors.

Lethbridge, Alta.—The bids for the sewage disposal works are given as follows:—

Tender	Firm	Price
No. 2.	J. A. Broley, Fernie, B.C.	$65,439.78
" 3.	Smith Bros. & Wilson, city	63,720.00
" 4.	Hotson, Leader & Goode, Lethbridge, Alta.	63,522.24
" 5.	W. Manders, Edmonton, Alta.	79,527.29
" 7.	Allison & Co., Toronto	65,987.48

The successful tender for the sewage disposal plant was that of Messrs. Hotson, Leader & Goode, of Lethbridge, at a price of $63,522.24. The consulting engineer for this work is Mr. T. Aird Murray, of Toronto. City engineer, Mr. A. C. D. Blanchard.

Lethbridge, Alta.—Following is the analysis of bids for street paving:—

Tender No.	Prices			Remarks
	$	$	$	
1. Dom. Pavers, Ltd.	3.97	3.99	3.94	4-in. wood block
Dom. Pavers, Ltd.	3.74	3.76	3.71	3½-in. wood block
Dom. Pavers, Ltd.	3.49	3.51	3.46	3-in. wood block
2. "National"	3.20	3.26	3.25	sheet asphalt
3. "Crown"	2.69	....	....	sheet asphalt
4. "Eloso"	2.65	2.69	2.59	sheet asphalt
"Eloso"	2.50	2.54	2.43	asphaltic concrete
5. "Kettle River"	4.45	4.47	4.43	3½-in. wood block
6. "Warner Quinlan"	3.05	....	....	sheet asphalt
7. "Bitulithic"	2.90	2.93	2.97	bitulithic
8. Gorman, Clancy & Grindley	....	....	2.49	Dolarway

The street paving is divided into two contracts, 17,000 square yards going to the "Bitulithic & Contracting Company," Winnipeg, at $2.93 per square yard; and 11,000 sq. yds. going to the "Eloso Company," Vancouver, at $2.43 per sq. yd. City engineer, Mr. A. C. D. Blanchard.

London, Ont.—Hon. F. D. Monk. Minister of Public Works for Canada, has awarded the contract for the new breakwater at Port Stanley to Mr. M. J. Hogan, of Port Colborne. The cost is estimated at about $275,000.

Ottawa, Ont.—The contract for the construction of the smallpox hospital on Porter's Island, has been awarded to Mr. George A. Crain.

Ottawa, Ont.—Messrs. Jones & Girourard are the successful tenderers for a bridge for the city of Ottawa, their price being $99,500.

Ottawa, Ont.—The Norton-Griffiths Company have received the contract for the work of the St. John Harbor Improvements, Courtenay Bay, this company having contracted to do the work for $7,700,000.

St. John, N.B.—Messrs. M. Connolly & E. P. Charleson have the contract for the construction of wharves at Sand Point, West St. John, at a cost of $800,000.

Sydney, N.S.—The Saunderson Manufacturing Company have secured the contract for the supplying of the necessary roofing velvet for the Dominion Iron & Steel Company's new nail mill, which is now being constructed.

Victoria, B.C.—The tender of Mr. Thomas Stedham for the erection of a reinforced concrete lighthouse, forty feet in height, together with dwelling, boathouse and oil-shed at Sherringham Point, near Sooke, has been accepted by the Marine and Fisheries Department.

Vancouver, B.C.—In connection with the Seymour Creek Extensions the following contracts have been awarded: Steel pipe, Messrs. Balfour, Guthrie & Co., for $75,900. valves, Messrs. A. J. Forsyth & Co., for $8,687; both are Vancouver firms. The contract for trenching has not yet been awarded.

Vancouver, B.C.—The Union Steamship Company have closed the contract for the extension to its dock, the successful tenderers being Messrs. O'Brien, McCaughey & Lamcke. The contract for the shore end of the improvements has been let to Messrs, Ironsides, Rannie & Campbell, and the contract for the new office building which will be erected there has been awarded to Mr. J. McNee.

RAILWAYS—STEAM AND ELECTRIC.

Eastern Canada.—A movement is under way to have the Dominion Government place the York and Carleton Railway under the management of the I.C.R.

Montreal.—A batch of charter amendments were put through the city council recently. They will form part of the Montreal bill to be submitted to the legislature at the present session. Among the powers the city is asking is the right to establish and operate or lease one or more underground tramway lines, to be operated by electricity or other motive power, and the right to regulate the operation of auto-bus lines.

Montreal, P.Q.—The Montreal & Northern Colonization Railway Company has applied to the Legislature for power to tunnel Mount Royal. The company is also seeking extension of the time limit for buliding its line from Montreal to the National Transcontinental.

Montreal, P.Q.—The municipal council are preparing a bill to be submitted to the legislature at the present session, asking the right to establish and operate or lease one or more underground tramway lines, to be operated by electricity or other motive power, and the right to regulate the operation of auto bus lines.

Montreal, P.Q.—The plans of the Canadian Northern Railway for improved passenger and freight facilities on the island of Montreal, were officially laid before the Board of Control on January 9th. These plans provide for a tunnel through Mount Royal, an elevated railway and a freight line.

Northern Ontario.—It is reported that further exploration of the James Bay slope of Ontario, as well as the Moose River estaury and the James Bay shore, will be undertaken next spring under the direction of the Temiskaming & Northern Ontario Commission.

Port Arthur, Ont.—The Canadian Northern Railway propose erecting a new steel dock. This dock will be about 800 feet long, and will be arranged so that several boats can unload at the same ime.

Ottawa, Ont.—A law suit involving rather a unique technicality is being heard in the courts. The Peerless Brick Company and the Canadian Northern Railway are the principals. The Canadian Northern Railway desire to expropriate the pits of the brick company, basing their compensation on the point that the property is mud. The brick company contends that the area is a "mine" of clay. It quotes the Railway Act, which states that a railway has not the power to expropriate lands which might obstruct the workings of a mine. The compensation asked for is $40,000, which the railway considers too large. The action has been adjourned until April 10, 1912.

Ottawa, Ont.—The management of the Ottawa, Montreal and Eastern Railway Company will apply at this session of parliament for extension of time to complete the work now under construction.

Toronto, Ont.—An application will be made by the Toronto Suburban Railway Company to the Legislature of the Province of Ontario at its next session for an Act authorizing the company: To extend its line from some point at or near Guelph, in the County of Wellington, to some point at or near Berlin, Preston, Hespeler, and Galt, in the County of Waterloo, and thence to a point at or near Hamilton, in the County of Wentworth, passing through or near the Townships of Guelph, Waterloo, Dumfries, Puslinch, Beverley, Flamboro West and Ancaster.

Toronto, Ont.—The civic percentage of the Toronto Railway Company's earnings for 1911 amounted to $687,650.44. In addition there was also $83,000 in mileage rates, and taxes of $50,000, or a total of over $820,000. The percentages show an increase of $91,353.09.

Toronto, Ont.—A proposal is under way for the construction of a railway to serve a portion of the fast growing suburban district around Toronto. The purpose of the three-mile railway, which will have Lambton and Sunnyside as its terminals, is to provide an efficient service for the property owned by the Toronto Land Corporation, the concern backed largely by English capital, which has promoted the Humber boulevard scheme. The route at present is purely tentative. As planned it runs down the west bank of the Humber from Lambton to Bloor Street, where it crosses and follows Jane Street to the Lake Shore Road. It might follow the Lake Shore Road, or might cut across the old Belt Line Railway about the brickyards, and cut Windermere Avenue and Ellis Avenue, crossing the Grenadier Pond on piles.

Toronto, Ont.—The plans of the new Union Station will be up for discussion and examination when the Dominion Railway Board sits in Toronto on February 8th. These plans will be completed and filed with the City Solicitor by February 1st, the idea being that a week at least should intervene to allow examination of them before the board's meeting. In this connection it will probably be necessary to bring up the whole question of the viaduct and the York Street bridge once more. The whole general question of the entrance of the Canadian Northern Ontario Railway to Toronto at the north end of the city, will also be up for discussion.

Western Canada.—A number of towns and cities in Western Canada are preparing to petition the government in an endeavor to secure the terminus of the Hudson Bay Railway.

Winnipeg, Man.—The appropriations which are now being prepared in Winnipeg for the work of the Canadian Pacific for 1912, will contain an item for the installation of over 1,000 miles of telephone circuits. It will not be long till the telephone system will be used throughout the main line and all branches as well for train despatching.

The authorized mileage of the Grand Trunk Pacific main line and branches is 11,500 miles, of which 1,745 miles are between Winnipeg and Prince Rupert. 1,800 miles are under contract by Transcontintnetal Railway Commission between Winnipeg and Moncton. The company claim that at the completion of railway the trip around the world will be shortened by about a week.

LIGHT, HEAT AND POWER.

Brantford, Ont.—Engineer Sothman, of the Hydro-Electric Commission, addressed the Brantford council, pointing out that Blue Lake and St. George, just west of Brantford, were desiring hydro-electric power, and if Brantford came in matters would be greatly facilitated. If not, these places would have to be supplied either from Dundas or Galt. It is considered likely that the by-law will be submitted to Brantford ratepayers at an early date.

Calgary, Alta.—An estimated total of $200,000 for electric light extensions for 1912 and $168,000 for extensions to the city power plant during the coming year have been ap-

Tarvia

Preserves Roads
Prevents Dust—

Charles Street, Stratford, Ontario, showing "Tarvia Modern Pavement."

Stratford's Experience with Tarvia

STRATFORD, Ontario, did some thorough and successful work with Tarvia X in 1910 and the accompanying photograph shows a section of Charles Street in that city built by the Tarvia Modern Pavement Method.

Tarvia X was used as a binder throughout the road on a Telford base. Although the job was done by the somewhat primitive barrel-and-kettle method, the total cost was only $1.32 per yard.

The Tarvia, filling the voids of the stone, acts as a plastic matrix, keeping the stone in position, preventing all internal movement, resisting water and frost, protecting the road against automobile traffic and preventing the formation of dust.

After its first year of use, the street is in excellent condition and is giving perfect satisfaction. It has been visited by various engineers, all of whom agree as to the success of the work.

This is only one of thousands of instances of successful Tarvia construction.

We will be glad to send to any inquirer a booklet showing many other cases.

The Paterson Manufacturing Co., Limited
Montreal Toronto Winnipeg Vancouver

The Carritte-Paterson Manufacturing Co., Limited
St. John, N.B. Halifax, N.S.

proved by the council. The particulars of the estimates in each case are as follows:—

400 additional street lamps, wire and labor	$40,000
Transformers for light and power	20,000
Meters	18,000
Cross arms	2,000
Poles	10,000
Hardware	5,000
Labor on overhead construction	40,000
New sub-station on Ninth Ave. West, and equipment	20,000
Underground lead covered cable (feeders) and labor	30,000
Sundry accounts	15,000
Total	$200,000

1 Exciter for 1,000 K.W. ry. motor generator	$ 1,000
4 Water tube boilers 350 H.P. each	32,000
Bricking in boilers	2,000
4 Mechanical chain grate stokers	8,000
1 2,500 K.W. steam turbo generator, complete	65,000
1 1,000 K.W. ry. motor generator, complete	25,000
1 Exciter set for 300 K.W. motor generator	800
1 Feed water heater, closed type	2,000
2 Feed pumps	4,000
Boiler and feed piping	2,500
Auxiliary piping	2,000
Foundations for turbine motor generator, feed pumps, feed water heater, etc.	2,500
1 5,000,000 gallon motor-driven pump	5,000
Extension to power house sewer	2,000
Sundry extensions	15,000
Total	$168,000

Montreal, P.Q.—Owing to the severe cold weather, considerable trouble was experienced by the Montreal Light, Heat & Power Company in their gas mains. The trouble existed in all parts of the city at once. The absence of the usual snow blanket gave the sudden severe frost easy access to the ground, and it penetrated to the level of the gas mains.

Ottawa, Ont.—One of the first measures to be brought before the new city council will be a resolution urging the Hydro-Electric Commission to expropriate for the City of Ottawa the water power on the Ontario side of the Chats Falls, owned by Hon. William Harty, of Kingston. The engineers sent down by the Hydro-Electric to investigate the Ottawa power situation have reported that the Chats Falls is by all odds the one best suited for the City of Ottawa.

Quebec, P.Q.—The contract by which the Dorchester Electric Company agrees to proivde the city's lighting for ten years is based on rate of seven cents per kilowatt hour, as against the present rate of 12 cents (or 15 cents if not paid within a certain time) charged by the Q.R.L and P. Company.

Regina, Sask.—The long delayed generator has at last been shipped by the constructors in England. It will likely be at least another month before the generator is installed by the local power house officials, and in the meantime the units at present doing service will have to continue carrying an overload. The generator was to have arrived in the city some months ago, but shipment was delayed. A shipment was made during November, and the power house officials were assured at that time that everything would be on hand during December. The shipment arrived, but consisted of the turbine only, the electrical equipment having been left out. The electrical equipment was shipped from Liverpool on December 22, according to communication. It is not expected that the shipment will reach Regina for several weeks, and another week willl likely be occupied in setting up the unit.

Saskatoon, Sask.—Some difficulty is being experienced in placing the machinery in the new power house as a result of defects of the travelling crane, and an employee of the manufacturers is investigating. It appears that the track on which the crane travels is all right, and the traveller itself could not be better, but the lifting power of the blocks is said to be less than the guarantee. The warranty from the manufacturer was to the effect that the crane would lift and carry a weight of fifteen or sixteen tons, but the crane has failed on lifting a weight to the extent of only six tons. It is thought that the blocks are not of the correct capacity, and, in view of this, an imperative wire was dispatched to the firm to send an expert forthwith to adjust it. This was necessary, as some of the parts of units to be installed weigh nearer twenty tons than sixteen, and the assistance of the crane is badly needed, its defection being severely felt in hampering the installation of machinery. Under the circumstances, it is doubtful if any accurate prediction can be made as to when the new plant will start in full operation, and in the meantime the overloaded old plant is being worked to its utmost capactiy. Preparations are being made for converting this plant into a pumping station directly the new system of power production is supplying the electrical energy which the city so badly requires.

Saskatoon, Sask.—The same generator which caused so much trouble at the city power plant a few weeks ago was again the cause of considerable inconveninece to the city. The trouble was due to the heavy load burning out three or four coils and these had to be replaced before the generator could be put in commission again. The burning out of the coils did not put the entire plant out of commission. One generator was still in working order aud thus sufficed to supply a feeble current to the city.

Toronto, Ont.—The Ontario and Minnesota Power Company, of Vernon, has applied for an injunction against the Rat Portage, the Rainy River and the Shevlin-Clarke Lumber Companies, the Northern Construction Company, and Lockhart & Company, to restrain the defendants from damming up the waters at the head of Rainy River. The power company has a large plant at Fort Frances. It claims that the defendants dams are constructed all the way up the river, some being 200 miles away, and that the flow of water is seriously weakened.

Among the questions taken up before the International Deep Waterways Commission which met in Washington, January 10th, was the proposition to render deep water navigation possible from the mouth of the Richelieu River at Sorel, up that river, through Lake Champlain and Lake George to Albany and thence to New York, and the Long Sault dam project.

SEWAGE AND WATER.

Berlin, Ont.—H. J. Bowman, of Berlin, has been engaged to prepare plans and specifications for the proposed extension to the waterworks.

Montreal, P.Q.—The Aldermanic caucus have decided to approve in council the recommendation of the Board of Control that the tax for water used for baths in dwelling houses should be abolished.

Port Arthur, Ont.—The city engineer has recently reported to the council upon a new and extensive water supply project for the city. The proposal includes the provision of new duplicate intake pipes at a location about two miles east of the present intake pipe, which was recently badly damaged by alleged dredging operations. Also the extension of a considerable length of force main and new pump station. The estimated cost is about $200,000. We understand that the whole project has been submitted to Mr. T. Aird Murray, of Toronto, as consulting engineer, and that that the new city council will do nothing in the matter until the report is received.

Toronto, Ont.—Mr. Isham Randolph, of Chicago, one of the members of the Board of Water Experts, sent to the Board of Control his account for services and expenses from March 20th to December 29th. The amount is $4,678, and includes railway and hotel expenses and his fee of $100 per day. He had been paid $1,500 on account, leaving a balance due of $3,178. The Mayor said the experts now only had to report on the cost of the larger scheme for a new intake and reservoir at Scarboro. Controller Hocken agreed with the Mayor that the sewage effluent would have to be chlorinated. Then, he thought, it would be safe to have another intake at Scarboro Heights, and he favored that plan. Ultimately there should be a third intake in the west. Three smaller units would be better than concentrating on one.

Vancouver, B.C.—The $100,000 Little Mountain Reservoir in South Vancouver, which was built under the direction of Consulting Engineer Burwell for the City of Vancouver, has been completed, and now contains several feet of water. The following are the dimensions of the reservoir and its capacity: Top length of reservoir, 612 feet; bottom length of reservoir, 514 feet; top width of reservoir, 377 feet; bottom width of reservoir, 280 feet; depth from top to bottom, 25 feet; slopes of inside, two horizontal to one vertical; top width of bank, 45 feet; width of base of bank, 145 feet;

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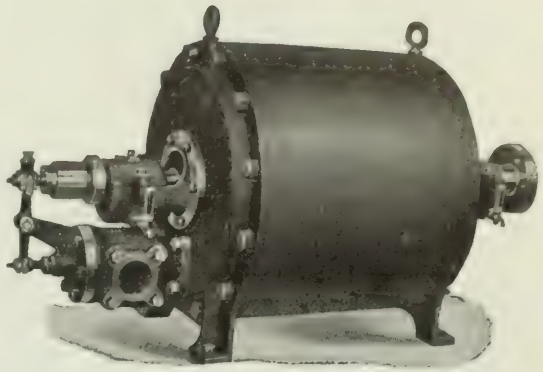

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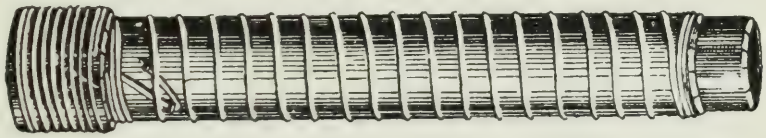

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total excavation, 80,000 cubic yards; rock excavation, 18,000 cubic yards; plain concrete lining, 15,030 square yards; reinforced concrete lining, 9,835 cubic yards; cost of excavation, $52,000; cost of concrete lining, $43,000; capacity when filled to the top, 29,000,000 imperial gallons; with a depth of 22 feet, 25,000,000 imperial gallons; elevation of top above sea level, 400 feet; total cost, $95,000, being $3.80 per 1,000 imperial gallons. The one 24-inch pipe into the reservoir acts both as inlet and outlet and is provided with a balanced valve inside of the reservoir, consisting of a vertical 24-inch pipe suspended within a steel tower, by which arrangement the outflow from the reservoir can be shut off when desired, and any additional connections or repairs made to the supply pipe without emptying the reservoir.

BUILDING.

Brandon, Man.—A new factory is to be erected by the Brandon Construction Company at the corner of Princess and 16th Street. The new factory is for manufacturing sash, doors, and other fittings for construction.

Montreal, P.Q.—Preparations for building a large concrete factory in the Park Avenue extension section are under way. It is understood that the factory will employ 400 persons. The property is situated on Beaumont Street, at the foot of King Edward Boulevard, and comprises an area of about 200,000 square feet.

Port Colborne, Ont.—About $50,000 was spent in Port Colborne during the year 1911 on building operations outside of the new Maple Leaf Mill. The buildings include a new bank building of terra cotta brick and a new theatre. The prospects for 1912 are the best in the town's history. The cement company is spending about half a million dollars, doubling its capacity. The cork works expects to double its capacity. The Union Smelting Works of Buffalo will erect a $200,000 plant, and it is expected the C.P.R. will run a branch line into the town.

CURRENT NEWS.

Carleton Place, Ont.—The by-law to borrow $150,000 to install a system of waterworks and sewerage in Carleton Place was carried by a majority of 216.

Castor, Alta.—A water tank near this point collapsed and crushed out the life of one young man.

Desbarats, Ont.—Owing to lack of a bridge, communication has been cut off between St. Joseph Island and the mainland. A large number of people are at Desbarats awaiting to get across, while many on the island from Sault Ste. Marie and other points are unable to return. Applications have already been made to both the Provincial and Dominion Governments for relief, by having the proposed bridge built.

Esquimalt, B.C.—According to a report of the American Consul at Victoria, B.C., the British Columbian Marine Railway have completed financial arrangements for the construction of a large graving dock at Esquimalt, which is to be 1,000 ft. long and will be constructed on similar lines to the one at Southampton. It is proposed to build the dock of reinforced concrete with granite facings and to employ electric plant for pumping purposes, etc. Work is to be started at once in order that the dock may be completed before 1915, or in time for the opening of the Panama Canal.

Fort William, Ont.—It is reported that the Good Roads by-law carried in all the townships in this vicinity except Oliver, and it is expected that the by-law will be legalized there.

Hamilton, Ont.—The Hamilton Bridge Works Company has been granted a building permit for the erection of five concrete, steel and corrugated iron buildings in East Hamilton for the Steel Company of Canada. The cost is given as $100,000, and the different buildings are: Rod mill, 83 by 550; bloom and billet mill, 65 by 400; open crane runway building, 50 by 400; boiler house and gas producing building.

Hamilton, Ont.—It is stated that $2,500,000 is the amount involved in the deal by which a large American gas and coke concern will shortly take over the Hamilton Gas, Light Company, and the Ontario Pipe Line Company, giving it control of the natural and artificial gas situation here. The Manufacturers' Gas Company will likely be taken in later, too. The new company will erect a mammoth new plant here and carry on an immense coke business.

London, Ont.—The comparative building statistics for 1910 and 1911 for London, Ont., are as follows:—

	No.	Value
1911 December	38	$ 187,553
1910 "	17	63,085
1911	1039	1,036,880
1910	882	805,074

Montreal, P.Q.—Estimates prepared from authentic information on building figures for 1911 show a total of $25,820,144 for Greater Montreal. While these figures are nearly two million dollars lower than those for last year, they are regarded as extremely satisfactory, since last year's figures were swollen by the taking out of permits by the C.P.R. for work amounting to several millions of dollars, while the present year has not been marked by any such immense expenditure.

Ottawa, Ont.—It was announced on January 9th that the good roads programme which the Federal Government proposes to inaugurate, will be attended to by Hon. Frank Cochrane, Minister of Railways. Mr. F. W. Campbell, the present Deputy Minister, will probably be the head of the new department.

Ottawa, Ont.—The main estimates of the Federal Government will contain an appropriation of approximately one million dollars for the further improvement of the St. Lawrence route. Much additional dredging will be done, particularly in the vicinity of Cap a la Roche.

Owen Sound, Ont.—The municipality are considering an offer recently made by the Standard Chemical, Iron and Lumber Company, regarding the installation of a blast furnace. The president, Major Peuchen, in an address to the ratepayers remarked that the company had decided to establish a smelter on the Georgian Bay, and they had almost closed the deal with Midland, which had offered a dock, a site, loan and bonus. If the ratepayers should decide to carry the project, the terms laid down by the company are: The town to furnish a dock to cost at least $30,000, and the speaker stated that if it cost over $35,000 the company would pay the extra cost. A bonus of $25,000 and a loan of $25,000 is also to be given the company, but the bonus is not to be handed over until the plant is erected and running. On the $25,000 loan the company will pay back $1,250 per year, and they will lease the dock at $100 per year. The dock will be 600 feet long. The town is also to furnish the company with a free site. The town council at an early meeting will take up the by-law for the raising of the necessary money, and if it receives its first and second readings, it will be submitted to the ratepayers to be voted on.

Province of New Brunswick.—The year 1911 in this eastern province was the dryest in seventeen years. The total precipitation of rain and melted snow was 26.25 inches, while the average for the past seventeen years was 34.68 inches.

Quebec, P.Q.—The municipal council is in receipt of a cheque for $300,000. This amount is a refund of a subscription raised to assist in the construction of the ill-fated Quebec Bridge. This refund was provided for in the Act of Parliament, passed at the instance of the Laurier Government, providing for the dissolution of the old Quebec Bridge Company and the assumption of its obligations by the Government of Canada, after the collapse of the first bridge.

Regina, Sask.—Provision has been made in the civic estimates of expenditures for the installation of a gas plant during the year, at a cost of $200,000. At the time the Street Railway service was inaugurated it was announced that the next civic undertaking would be a municipal gas plant, and provision is made for a start on the work during the early part of 1912. Although the plant is to cost $200,000, only $20,000 is provided for the start on construction, investigations as to the best plant, probable revenue, advisability and necessity for plant.

Toronto, Ont.—In the past five years the total increase of assessable property in this city amounts to $159,571,000, and at the present time the total taxable amount of assessable property is $806,751,673. These figures show an increase of $32,239,000 over last year.

Vancouver, B.C.—Mr. A. D. Swan, who has been employed by the Dominion Government to plan Greater Vancouver's harbor improvements, and Mr. R. S. Lea, who is laying out a scheme of sewerage for Greater Vancouver, arrived from Eastern Canada, and at once began the preliminary

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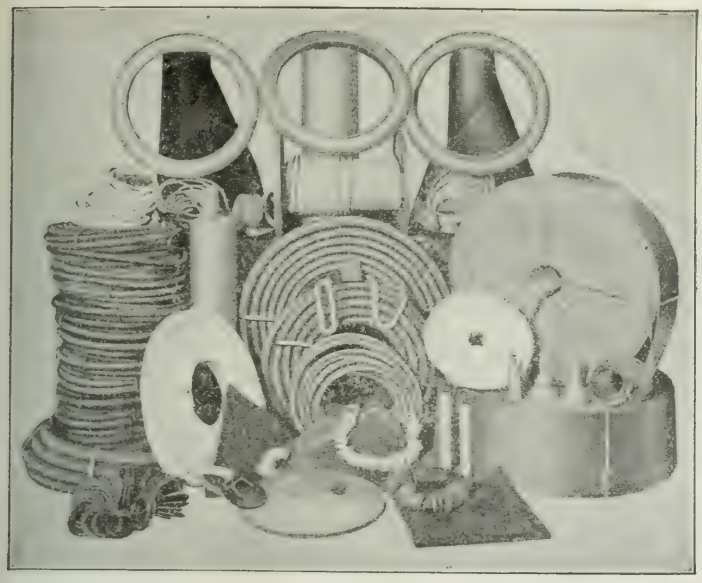

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ary work of getting in touch with local conditions. It is understood that Mr. Lea is now prepared to place the whole sewerage scheme before the joint committee, defining the position of the mains that will have to be constructed at once and also outlining the work necessary during the next ten or fifteen years.

Welland, Ont.—The building figures for Welland, Ont., for 1911 is as follows: Public and business, $213,878; residences, $128,930. If the factories and residences erected in the suburb (Welland South) were added, the total would exceed $1,000,000. During last year an unsuccessful effort was made to extend Welland boundary to take in Welland South.

York County, Ont.—Mr. E. A. James, engineer for the York County good roads, has located an important stone showing about twenty miles from Toronto. This rock can be placed f.o.b. any siding in York county at less than $1.90 a ton, and since this is an exceedingly hard and tough rock and can be delivered at a price almost equal to that of granite, the engineer predicts that it will be the rock largely used in macadam highway construction in this section of Ontario from this time forward.

The Asphalt & Supply Co., Ltd., 213 St. Nicholas Bldg., Montreal, Que., would like to get in touch with some of the larger construction companies on the Pacific coast and middle west, who make a specialty of street and sidewalk paving work. Any firms who are interested are invited to correspond with the company at the above address.

LIST OF PRIVATE BILLS OF ONTARIO LEGISLATURE.

An application has just been received from the Kawartha Transportation Co., who want to build an electric car line in Peterboro, and from there to several of the summer resorts on the Kawartha Lakes.

The Bruce Mines and Algoma Railway Co. want to extend their line from Rydall Bank Station to Algoma, north and east to Hanna and other points on James Bay. The railway company also wants to increase its bonding power to $30,000 a mile.

The town of Brampton wants to introduce a by-law to permit the issuing of bonds amounting to $23,000, to assist the Peace Foundry Co. in obtaining a site for a new plant there.

The town of Haileybury wants power to issue $26,000 worth of debentures for various municipal improvements, including a firehall, municipal building and waterworks extensions.

The town of Milton wants an agreement to guarantee the issuing of bonds to the Williams Shoe Co., who are planning to locate a shoe factory in that town.

The town of Renfrew is making application to validate two by-laws, one for $60,000 for an electric power plant and steam auxiliary. The municipality also wants to install its own lighting plant.

The Dunnville, Wellandport and Beamsville Electric Railway have made application to have a four years' extension made to the time in which the railway is to be completed.

NOVA SCOTIA MINERALS.

The mineral production of Nova Scotia for the year 1911 shows a large increase over the production of the year 1910, and is the largest in the history of the mining industry of the province. The different branches of the industry, with but three exceptions, show large increased outputs, whereas the decreases shown are very small. With the exception of iron ore, pig iron, steel, prices have been the same as during the preceding year.

A total of 6,400,000 tons of coal were mined, this being an increase of 700,000 tons over the production of 1910. The Dominion Coal Company took over and reopened the mines of the Cumberland Railway and Coal Company at Springhill, and have during the year opened three new mines in Cape Breton County. This company have at the close of the year fifteen producing mines and five mines in stage of development on the Island of Cape Breton. At Stellarton the Acadia Coal Company have been engaged in extensive alterations and additions to their equipment, electrifying their plant. At North Sydney the MacKay Mining Company have completed and are now operating a Coal Briquette Plant.

The production of coke for the year was 500,000 tons, an increase of 55,000 tons over the 1910 production. The prinicpal producers and users of coke in the province are the Dominion Iron and Steel Company, and the Nova Scotia Steel and Coal Company.

A total of 840,000 tons of iron ore were imported into the province: 140,000 tons more than the amount imported during 1910, and 40,000 tons of ore were mined in the province, this being 10,000 tons less than the amount mined during 1910.

400,000 tons of pig-iron and 445,000 tons of steel ingots were made, being increases of 50,000 tons and 33,000 tons respectively. The iron-ore, pig-iron and steel markets throughout the world have been dull, and prices consequently low.

At Torbrook the Canada Iron Corporation have completed an ore concentrating plant. This company, in August, on account of the unsatisfactory condition of the iron market ceased to operate their mines. Operations are to be resumed just so soon as the market conditions improve.

At Scheelite, Moose River, the Scheelite Mines, Ltd., continued the development commenced last year in connection with their Tungsten areas. Additional shafts have been put down and long levels driven, good ore has been encountered, a modern concentrating mill and power house have been constructed, the equipments placed and the plant is now in operation. Ore shipments will be made early in the New Year.

At New Ross, the Nova Scotia Manganese Company have lately completed a concentrating mill and power house, and have part of their machinery in place; recent development work at their mine has opened up large bodies of high grade pyrolusite. This company is now prepared to make shipments of ore.

At Lake Ainslie, Cape Breton, the Byrites, Limited, have recently completed a modern mill, and expect to commence shipment of their products early in 1912. The milling of byrites at the mine is a new departure for the province; in the past all ore being shipped from the mines in a crude state.

The following table shows the approximate values of the mineral production of the province for the year:—

Value of Nova Scotia Mineral Products—Year 1911.	
Coal	$19,200,000
Steel	8,900,000
Pig Iron	4,800,000
*Iron Ore	2,475,000
Coke	2,200,000
Quarry products	880,000
Gold	142,000
Clays	190,000
Miss. Scheelite, Manganese, etc.	100,000
Total	$38,887,500

* 120,000 Nova Scotia ore balance imported.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners. to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

15639—December 19—Relieving C.N.R. from further protection at crossing east of switch at Dauphin, Manitoba.

15640-51—December 20—Authorizing C.N.R. to construct across public road on its Maryfield Extension, Saskatchewan, and two highways on same extension in Saskatchewan.

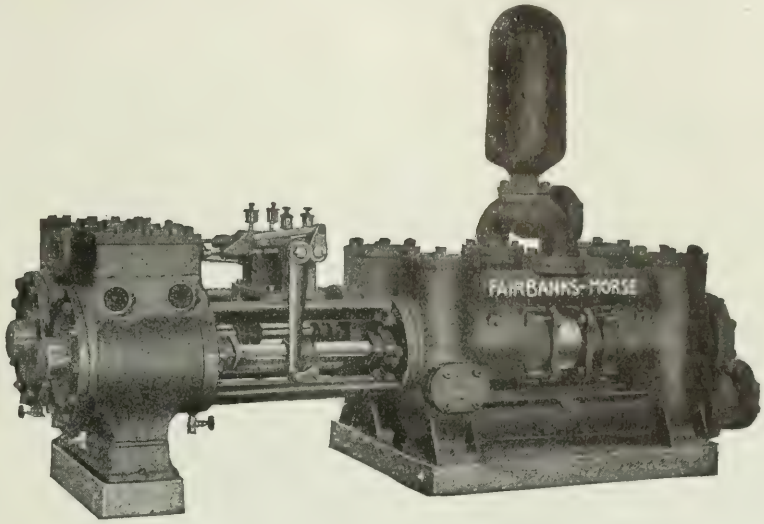
15642—December 20—Authorizing C.N.R. to cross with its Rossburn Line highway and to divert same in Saskatchewan.

15643-44-45—December 20—Approving revised location of C.N.O. Ry. (Montreal-Port Arthur Line), through Twp. of Ross, Ontario, (Renfrew County); and through unsurveyed territory in Dist. of Algoma, mileage 148 to 166 from Sudbury Junction; and revised location through Township of Loughborough, Ct. Frontenac, Ont.

15646-47-48-49—December 20—Authorizing C.P.R. to construct spur for Carbon Oil Company, Ltd., in municipality of Rosser, Manitoba; for city of Moose Jaw, Sask.; for Continental Oil Co., Ltd., Lethbridge, Alberta; for Eley Bros., near Woods, Manitoba.

15650—December 21—Amending Order 15594, of December 12th, 1911, by striking out words "Canadian Pacific Railway Company."

15651-52—December 20—Authorizing T.H. & B. Rv. to operate two spurs in city of Hamilton, into land of Laidlaw Bale Tie Co., Ltd., and also spur into lands of Canadian Drawn Steel Company, Ltd., Hamilton, Ontario.



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15653—December 20—Approving plans of G.T.R. for new station at Exeter, Ontario.

15654—December 16—Directing that upon conveyance by the Petrolea Waggon Co., Ltd., of land necessary for interchange track to be constructed by G.T.R. or M.C.R. Cost of work to be divided equally between companies. Application, town of Petrolea, Ont., and manufacturing interests.

15655—December 20—Authorizing city of Fort William to open up Victoria Avenue across C.N.R. at Vickers Street, an additidonal width of 14 feet.

15656—December 20—Directing C.P.R. on or before April, 1912, to submit plans for station at Dysart, Saskatchewan.

15657—December 13—Authorizing B. C. Electric Railway to cross C.P.R. at foot of Twelfth Street, city of New Westminster, B.C.

15658—December 21—Approving location of C.N.R. station to be erected at Veregin, Saskatchewan.

15659—December 19—Directing that effective dates of new freight tariffs required to be filed under Order 12520 of December 10th, 1910, be changed to April 1st, 1912. Tariffs to be filed by C.P.R. and C.N.R. Regina Rates Case.

15660—December 20—Authorizing C.P.R. to construct a spur for T. Kinnear & Co., in city of Peterborough, Ontario.

15661—December 22—Directing that T.H. & B. Ry. maintain light on electric bell at Mohawk Road crossing, mileage 62, from Welland, in city of Brantford, and as soon as same is installed railway company be released from speed limitation at said crossing.

15662—December 21—Relieving C.P.R. from further protection at crossing between Makarooff & Togo, between mile posts 253 and 254, from Winnipeg, Kamsack S.D., 3rd District.

15663-64—December 21—15665—December 22—15666—December 21—Approving location of C.N.O. Ry. station grounds at Lombardy, in Twp, of South Elmsley, at Perth Road, in Township of Loughborough, at Elgin, in Township of South Crosby, at Bedford, in Township of Bedford, Ont.

15667—December—Authorizing G.T.R. to construct spur to premises of St. Mary's Portland Cement Co., Ltd., and Horse Shoe Quarry, in Township of Blanchard, Oxford County, Ontario.

15668—December 21—Extending until January 31, 1912, time for completion of work to be done under Order 14164, dated June 24th, 1911.

15669—December 16—Authorizing G.T.R. to construct bridges at Mill, Peter, Barrett, and Ontario Sts., Port Hope, Ont.

15670—December 16—Re G.T.R. taking lands in Twp. of Etobicoke, Ont., of W. H. Miles, referring taxation of costs under sub-clause (e) of Clause 1 of Order 13418, to J. H. Thom, Taxing Officer of Supreme Court of Judicature for Ontario. Amount taxed and allowed by him to be paid by G.T.R. to applicant.

15671—December 22—Authorizing G.T.R. to construct track on east side of Metcalf St., town of Simcoe, Ontario.

15672—December 22—Amending Order 14606 of August 21st, 1911, paragraph 4, re interswitching at Brandon, Man., $2.00 per car to be revenue of Brandon, Sask. & H.B. Ry. on empties transferred between C.P.R. and C.N.R. at Brandon.

15673—December 22—Approving location of C.N.O. Ry. at Cushing, Que.

15674—December 23—Approving location of South Ontario Pacific Ry. (C.P.R.), proposed station at Waterdown, Ontario.

15675—December 23—Relieving G.T.R. from further protection of 1st crossing west of Port Robinson, Ont.

15676—December 22—Authorizing C.N.O. Ry. to cross and divert public road between Cons. 1 and 2, Twp. of South Elmsley, Ct. Leeds, Ont.

15677—December 23—Approving location of C.N.O. Ry. through Twps. of Chisholm and Ferris, Dist. of Nipissing, Ont., mileage 325.23 to 343.55 from Montreal.

15678—December 16—Varying Order No. 15151, of October 12th, 1911, that gates be put outside of tracks of C.P.R., and new plan to be filed for approval, Royce Ave. Gates, Toronto, Ont.

15679—December 23—Authorizing C.P.R. to cross with its Moose Jaw Northwesterly Branch across highway at mileage 202.77.

15680—December 26—Authorizing C.P.R. to open for carriage of traffic (freight) its railway from Coldwater, mileage 12.2, to Bethany, mileage 88.2.

15681—December 26—Authorizing C.P.R. to reconstruct bridge No. 127.2 on Mountain Subdivision.

15682—December 26—Authorizing C.P.R. to open for carriage of traffic its second track, Moose Jaw S.D., mileage 127.68 to 134.43 from Moose Jaw to Pasqua.

15683—December 23—Recommending to the Governor-in-Council for approval, Rules of G.T.R. Transportation Department.

15684—December 26—Extending until June 30th, 1912, time for completion of spurs into premises of Durham Rubber Co., Bowmanville, Ont., by Toronto Eastern Railway (C.P.R.).

15685—December 23—Directing Central Vermont Railway to ballast its entire line between St. Lambert & Waterloo, Marieville & St. Cesaire, Farnham and Frielsburg and Iberville and Farnham, and repair all bridges, farm crossings, highway crossings ,and fencings, ballast to be 6-inch lift. Work to be completed by October 1st, 1912 and that within 30 days from date of this Order, frogs and guard rails be filled, under penalty of $25 a day.

15686-87—December 27—Authorizing C.P.R. to reconstruct bridge No. 127.2 on Mountain S.D., B.C. Division, and bridge 94.8 on Moose Jaw S.D., over Wascana Creek.

15688—December 27—Authroizing C.P.R. to construct spur for Park Fuel and Lumber Co., at Calgary, Alberta.

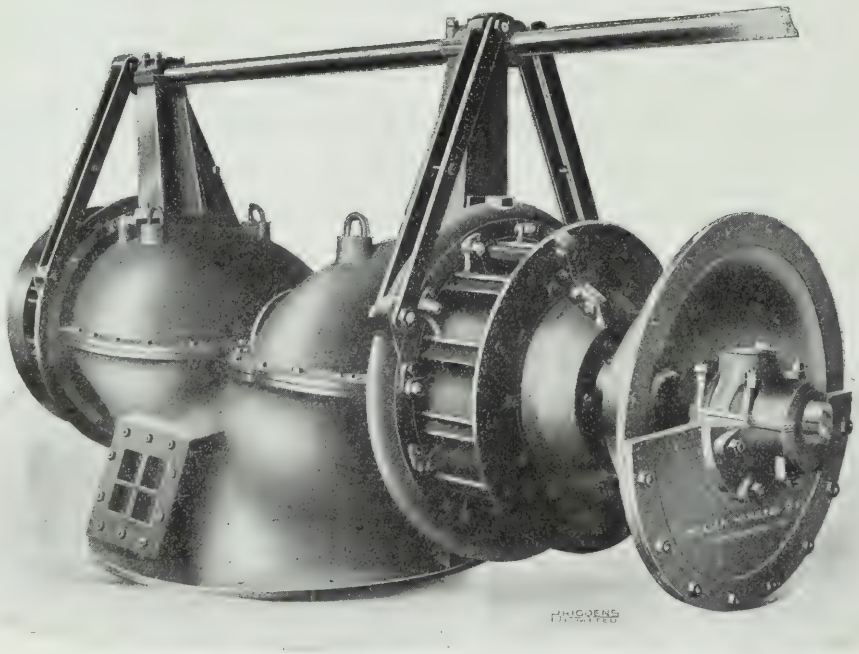
15689-90—December 27—15691—December 23—Approving location of C.N.O. Ry. through unsurveyed territory in Dist. of Algoam, mileage 287 to 307, from Sudbury Junction, and from mileage 307 to 327, from Sudbury Junction, and approving revised location through Twps. of Alice, Fraser, and Richards, in County of Renfrew, Ont., mile 209 to 225.42 from Montreal.

15692—December 27—Directing that C.P.R. install improved type of electric bell at crossing of County Road, 1¼ miles east of Ivanhoe Station, Ontario; 20 per cent. from Railway Grade Crossing Fund.

15693—December 27—Authorizing C.N.R. to construct a spur line to Ritchie Coal Co.'s yards at Edmonton, Alta.

15694—December 27—Authorizing C.P.R. and G.T.P. B.L. Co., to operate their trains over crossing pending installation of interlocker required to be constructed by Order 13663, of May 16, 1911, Melville-Regina Branch, G.T.P. and C.P.R. Bulyea Branch.

15695—December 28—Recommending to the Governor-in-Council lease for sanction between C.P.R. and Dominion Atlantic Ry.



Water Wheel Installations

for all power purposes

WILLIAM HAMILTON COMPANY, Ltd., Peterborough, Ont.

Volume 22. Toronto, January 18, 1912

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The Canadian Engineer

An Engineering Weekly

MONTREAL.

Montreal, the commercial metropolis of Canada, situated at the head of navigation, is now entitled to be classed among the great cities of the world. Including the annexations during the past few years, it has a total area of slightly over forty square miles. It extends a distance of about twelve miles in length along the harbor front and its northern extremity floats upon the Riviere des Prairies which, together with the St. Lawrence, makes the Island of Montreal. Of the territory embraced within the borders of the city, a very considerable area would hardly be recognizable as city property. A certain proportion of it is country district; but houses are springing up in every direction and ere many years have passed the entire area will, no doubt, assume the appearance of the suburbs of the city. It may be worthy of remark that until 1910 the area of the city was only in the vicinity of twenty square miles, the additional twenty having been added through annexation of outlying districts since then.

In the matter of population Montreal has increased very rapidly, having almost trebled in twenty years and having considerably more than doubled in ten years, as the following will show:—

Population of Montreal in	1891	[illegible]
do	1901	[illegible]
do	1910	450,000
do	1912	600,000

It must be admitted that a certain proportion of the above increase was due to annexation of outlying districts. Included in the above figures is the population of some districts which, strictly speaking, are really not portions of the city proper but which, in any consideration of the present character, must be included. For instance, West mount's population of 15,000 is included, as is Outremont's 5,000 and some 20,000 in Maisonneuve. This, however, is quite justifiable when it is remembered that Montreal surrounds each of these municipalities and even the citizens of the city, itself, would be unaware that they would be passing through a separate municipality.

In point of population Montreal now stands somewhere among the largest thirty or thirty-five cities of the world. In a recent comparison she stood ahead of Pittsburg, Birmingham, Leipzig, Detroit, Rome, San Francisco, Cincinnati, Mexico, New Orleans, Bristol and other well known large cities and capitals.

Mr. Jas. J. Guerin, Mayor of Montreal.

The increase in population and area, large as it has been, is small when compared with the increase in valuation of taxable property which has taken place. Within five or six years the value of the property has more than doubled, according to the report of the assessors. The value of the property exempt from taxation also has more than doubled. Exemptions for the most part consist of civic property which is owned by educational, charitable or religious organizations. These exemptions in a city which never has sufficient money to carry out works of a character which are representative of good government, have been fruitful of much discussion. An attempt was made a few years ago by which many of the exemptions would be transferred to the taxable list, but little came of it. The following shows the growth in the value of the property under discussion since the beginning of the present century.

	Exempt.	Taxable.	Total.
1900	$ 37,000,000	$148,000,000	$185,000,000
1905	46,000,000	173,000,000	219,000,000
1911	120,000,000	381,000,000	501,000,000

Included in the exemptions are some 38 parks and public squares having an area of slightly over 800 acres and a value of $12,000,000.

During the year 1911, the values of the building permits taken out at the City Hall was approximaely $15,000,000. These figures, of course, represent only new construction in the city proper. Not included in the figures, however, are the newly annexed wards of Longue Pointe and Notre Dame de Grace, these wards having been expressly exempted from the building regulations of the city. It was estimated also that the values registered at the City Hall were 40% under the actual value. In addition to this there is to be added for Westmount $1,335,000; Verdun, $600,000; Outremont $1,500,000; and Maisonneuve, $2,000,000. Altogether, therefore, it is considered that the total building operations for Montreal and vicinity amounted to $26,000,000. This compares with about $28,000,000 the previous year, so that a slight falling off is shown. To explain the falling off, it is only necessary to remember that the permits for some of the largest buildings ever undertaken in the city were taken out in the year 1910.

Some of the principal buildings constructed during the past few years may be shortly referred to as follows:—

The extension to the Windsor Depot. This comprised an enormous amount of work. The addition was on the down-hill side of the original Windsor Depot, extending for about a block, the lower end resting upon St. Antoine Street, and the frontage all the way along being on Windsor Street. The St. Antoine Street end of the building had to be a couple of stories higher than the original building in order to bring the roof in line from end to end. The building is not yet completed and some nice engineering problems were involved.

Two very fine buildings undertaken by Lyall & Sons this year were the Transportation Building and the Dominion Express Building. These are two of the largest office buildings in Canada, the former being considered the largest. In the construction of this building it is likely that a record was made. The contractors only obtained possession of the site on the 1st of May. It took three weeks to remove the buildings thereon, and by the middle of August the excavation had been performed and the steel structural work, comprising 3,000 tons, completed. Meantime, the bricklayers and masons had begun work on the 24th of June and by the 11th of September the entire building, ten stories in height and covering a block, was roofed in and ready for the interior work. During this period, 30,000 cubic feet of stone and 1,250,000 brick had been put in place. Just across the corner, work was being proceeded with, simultaneously, upon the Dominion Express Building, on the site of the old St. Lawrence Hall. Some difficult engineering problems were here carried out also, the Foundation Company have done some very interesting work on the concrete piers, the same company having also carried out work on the Windsor Station, referred to.

Macdonald Physics Building, McGill University.
View from Southwest. Mr. A. T. Taylor, Architect.

Other big buildings carried out by Lyalls during the last couple of years were the Yorkshire Building, just across from the Dominion Express; the Technical School up on Sherbrooke Street and the Willis Building on St. Catherine Street.

Other big buildings now in course of construction are the Ritz-Carlton Hotel on Sherbrooke Street, by the Fullet Company. Nearly opposite it the new Art Gallery, a beautiful building of classic architecture, is being constructed by the same company. Several reinforced concrete buildings of the skyscraper type—which in Montreal is confined to ten stories—have been constructed in the upper section of the city during the past few years. Probably the first and one of the finest and largest, is the Jacobs Building, on St. Catherine Street. The Blumenthal Building on the same street, farther east, and the Kellert Building, yet farther along, as well as the Wilder Building on Bleury Street, nearby, are all buildings of much the same character, constructed during the past few years. These mark the progress of the building in the city and more especially the transition of the uptown section from the two and three story era into the eight and ten story era. Practically all these new reinforced concrete and other sky-scraping structures involve engineering problems, particularly along certain sections of St. Catherine Street, where the nature of the ground necessitates going to solid rock in order to obtain safety.

Montreal has practically solved its great harbor problems. For years this was the one thing Montreal talked about. A dozen or thirteen commissioners used to gather down at the harbor office and discuss ways and means. Meantime the ships came to an antiquated harbor. The wharves were constructed of wood and the sheds of the same material. Owing to the high water and ice shoves of the early spring, it had been found necessary to construct a dyke all along the harbor front, with openings for access to the wharves below. Each fall all the buildings on the wharves and the wharf levels on the harbor front had to be pulled down and piled away in such a manner that they could be erected again the following May. When the ice began breaking up in the spring the openings in the dyke were closed in by gates in order to prevent the lower part of the city from being flooded when the ice shoves began. Until the ice jam in the river below broke and allowed the waters to subside not a sign of the wharves could be seen along the whole harbor front, the river being high above them. When the water fell, tons upon tons of ice would be left piled high all over the wharves. There were no grain elevators of consequence along the harbor front, and the loading was done mainly by floating grain elevators, operating on barges or lake steamers loaded with grain and moored alongside the out-going steamer.

Half a dozen years ago the old Harbor Board, which spent its time mainly fighting, was dispensed with and the work was handed over to a commission of three. Since that time the most wonderful progress has taken place along the harbor front. High level wharves of a permanent character have been built, and practically indestructible and fireproof sheds have been erected upon them. The capacity for docking ships has been largely increased, and as the sheds are two stories high their capacity for freight accommodation is several times that of the old sheds. Goods are stored here throughout the entire winter. The dyke is constructed of stone. Several modern grain elevators, two of which are the property of the harbor commissioners, have been built along the harbor front. These are being added to by the commissioners as quickly as possible. Conveyor belts carry the garin to the ships at almost all points in the centre harbor. The commissioners have their own locomotives for handling cars along the harbor front, and a proper system of tracks and switches lead down between the lines of sheds on the different piers. Floating cranes, with enormous lifting capacity, and devices of all kinds for the rapid loading and unloading of vessels have been installed. Meantime, also, the deepening, widening and buoying of the ship channel between Montreal and Quebec and below have been carried out, until ships may proceed by day or night with reasonable safety. Accidents in the channel are now almost unheard of.

The programme of the commissioners, however, is by no means completed. Comprehensive plans covering ten or twelve years' work were laid down shortly after they took office, and when these have been carried to completion Montreal will be—as it is to a large extent now—one of the best equipped ports in the world.

While, heretofore, the principal engineering problems in the vicinity of Montreal have probably been in connection with the harbor and channel, other problems are now arising which will undoubtedly claim a large share of attention during the next decade or two. A means of rapid transit throughout the city of Montreal and connecting up with points outside the city must quickly be devised and the problem will call for the exercise of the greatest skill and ingenuity. The south shore must be connected up with the city, by means of a bridge or tunnel, or partly by bridge and partly by tunnel, the Grand Trunk bridge above the city being inadequate for the general purposes of the citizens. Whatever method is employed accommodation must be provided for foot passengers and for the passage to and fro of street cars and vehicles of all kinds which may require access, and in addition thereto must be provided accommodation for the various railways which approach Montreal from the south. Consideration is already being given to this undertaking, but the problem is a very difficult one, and it is impossible to say how it will be solved.

Equally important is a means of rapid transit within the city itself and a more rapid approach to the heart of the city, both for street cars and for passenger trains, more especially from the west and from the north. The problem becomes all the more difficult because of the location of Mount Royal, immediately back of the city. Ere many years, the city will have extended completely around the mountain. In fact, it may already be said to have done so; and it is the growing needs of the residents of the outlying districts to reach the centre of the city, which is occasioning the present clamor for more rapid transit.

Many suggestions have been made respecting quicker transit in the city itself. Chief among these is the subway project. Nothing definite has yet been proposed, but there is talk at the present moment of applying to legislature for the right to construct a subway or tunnel, and to operate municipal street cars therein. Included in the same discussion is the question of permitting the operation of motor busses on the different streets.

Of a more immediate character than any of the above, however, would seem to be the problems raised by the Canadian Northern Railway. Precisely what it is the intention of the Canadian Northern Railway to propose to the city is not yet known. The railway, however, intends to take the matter up with the city at almost any moment, and ere this article appears will probably have done so. Meantime, it is commonly reported—and there is every reason to accept this report—that the railway has purchased a site for depot and terminals adjacent to the present quarters of the Canadian Society of Civil Engineers, which is a short distance east of Dominion Square, and within a few minutes of the C.P.R. Windsor depot. How the C.N.R. proposes to reach its new terminal is the interesting question. The most-talked-of

means is through a tunnel to be constructed under Mt. Royal. It is understood that the tunnel would enter the mountain immediately in rear and come out at the new depot, a distance of probably three miles through. This would undoubtedly be the quickest means of access to the city which has yet been considered. An alternative proposal is entry by means of a viaduct. From its depot the C.N.R. would make connections with the harbor front by means of an elevated track.

Work on the Highlands Side of the River.

All this brings up the equally important point of motive power. The citizens are becoming tired of breathing tons of coal dust. Scores of locomotives are constantly puffing to and fro, making discordant noises and emitting volumes of smoke, the unpleasantness of which need not be described. It has already been proposed that both the C.P.R. and G.T.R. should electrify their systems in order to place themselves in a position to discard their smoky locomotives. The C.P.R. has probably declined; but of course it is only a matter of time until it will have to give its assent. Fortunately, Montreal is well supplied with power. The Montreal Light, Heat & Power Co. has contracted for at least 30,000 h.p. more than it is making use of at the present moment, and no doubt it could add yet 50,000 to this if necessity arose. The Cedar Rapids development is now going on. From this will be drawn 50,000 h.p. on the first installation, and yet other installations are to be added. Several other water powers of a minor character are located within commercial distance of the city. The promoters of the Long Sault dam project promise hundreds of thousands of horse-power for Eastern Ontario and Quebec. It would, therefore, seem that there need not, for a long time to come, be any trouble in obtaining all the hydraulic development necessary to operate the industries of the city, and to electrify the various railway terminals.

It is estimated that by 1920 Montreal will have over 1,000,000 inhabitants. There seems no reason at present to doubt that this prediction will be fulfilled. Industries of all kinds and with enormous requirements for employees are being added year by year. Undertakings of a magnitude undreamed of until lately are calling for immediate attention. Railway and canal construction, harbor and river improvements, rapid transit requirements, hydraulic power construction, underground conduit systems for the reception of overhead wires, better electric lighting and telephone service, more efficient fire protection, including proper provisions for the construction of modern fireproof buildings; increased water supply and a filtration system on a large scale, sewage disposal—all these are problems which Montreal is now facing or will have to face within the next few years. There is work for the engineer.

NEW FOUNDATIONS FOR THE C. P. R. LACHINE BRIDGE.

In the finishing of the foundations for the above bridge on or about December 1st of this year, the heaviest piece of construction encountered on the Farnham Section of the Canadian Pacific Railway in its double tracking, is completed.

The old bridge was located about two miles above the well-known Lachine Rapids, and was a single track structure 3,657 ft. 6 in. long between abutments, with three 80-ft. deck plate girder spans, one 120-ft., two 270-ft. and eight 240-ft. deck truss spans, and two through truss spans about 408 ft. centre to centre of piers, supported on two abutments, two land piers, and thirteen river piers. The work of extending the lines to accommodate the double track of the bridge involved the extension of the existing piers and abutments, and the construction of four new river piers to allow the replacing of four of the original 242-ft. spans by eight 121 ft. spans.

All of the new piers and the extensions to the old, are of rock-faced limestone ashlar with concrete footings carried down to bed rock, at a maximum depth of 37 ft. below water level. This bed rock was covered with from three to sixteen feet of gravel and large boulders, and large bodies of riprap deposited from time to time around old pier.

A current of from eight to ten miles per hour had to be contended with, and the force of the current can be better appreciated by the fact that the pressure against the caissons for the deep water piers was estimated to be no less than 100 tons.

For the construction of the four new river piers, open cofferdams with puddled walls were used. The overlying sand and gravel was dredged off and the cribs, after being carefully fitted to the irregularities of the rock bottom, were sunk in the required position. The rock in puddled chamber was then cleaned off with divers. Sheeting was driven and the space between the two walls filled with puddle clay. The cofferdam was then pumped dry, permitting the rock to be cleaned off and the concrete deposited in the open.

C.P.R. St. L. R. Bridge. View of Piers on Highlands Side of River, Just Before Steel was Placed on the Down-stream End.

With the exception of seven of the piers, where the water was deep, the extensions to the existing piers were made in substantially the same manner. The cribs for these were closed in on three sides only and so arranged that the sides would overlap and fit closely against the old cofferdams used in the original construction of the bridge which had been left in place. After these joints had been carefully caulked by

divers, and the cofferdam walls puddled with clay, no difficulty was experienced in unwatering with 8-inch centrifugal pumps. Practically all of the leakage came from open joints in the old cofferdam.

The foundations for the extensions to the seven remaining piers, where the depth of water was from 20 to 27 ft., were carried down to rock by a combined pneumatic and open process. In order to reduce the current from 8 to 10 miles an hour, to about 2 or 3 an hour at each of the seven piers above mentioned, breakwaters were constructed on both sides of each old pier.

Showing Erection of Channel Piers.

A derrick boat equipped with grapples and an orange peel bucket were then used in removing the riprap and boulders to allow the pneumatic caissons to rest on a comparatively level bottom when they were sunk.

The pneumatic caissons were constructed of long leaf yellow pine. The walls were heavily cross-braced in the usual manner. A single shaft with the contractor's standard type of air-lock was used for both men and material.

It is customary to build caissons for river work on the shore, launch them in the usual manner, then tow to position. On account of the heavy current at this bridge site, it was considered advisable to build each caisson in place. Accordingly, the contractors constructed a pontoon of sufficient size to sustain the caisson without drawing more than a few feet of water. As fast as they were required for the work, the caissons were constructed in this pontoon and anchored with steel cables to existing piers. The temporary bolts in the pontoon were then withdrawn, allowing the pontoon to fill with water and the pontoon pulled from under the caisson as it settled in the water.

After a caisson was launched, the same pontoon was towed to the next pier. When launched, the caisson was located and was sunk to bottom of river. Walls of caisson were built up and caulked as caisson went down.

All pneumatic caissons were sunk at the end of the footings of old pier, which were rectangular in shape. There was therefore left two triangles to be filled up between pneumatic caissons and old foundations of old pier. These triangles were dredged out as near solid rock as possible, then a cofferdam was built on each side of extension attached to pneumatic caisson on one end, and old footing on other. Divers were then sent down to clean off bed rock. Concrete was deposited under water in the triangles for a few feet by means of a special submarine bucket. This cofferdam was then pumped out and huge I beams were then placed in concrete, one end resting on pneumatic caisson and the other on the old pier. All was then concreted to the elevation where the masonry started.

Material for piers Nos. 3 to 7 inclusive, where the water was shallow 4 to 10 ft., was delivered to the work by means of a tramway 1,000 ft. long. Derricks were attached to old bridge and two derrick boats used also.

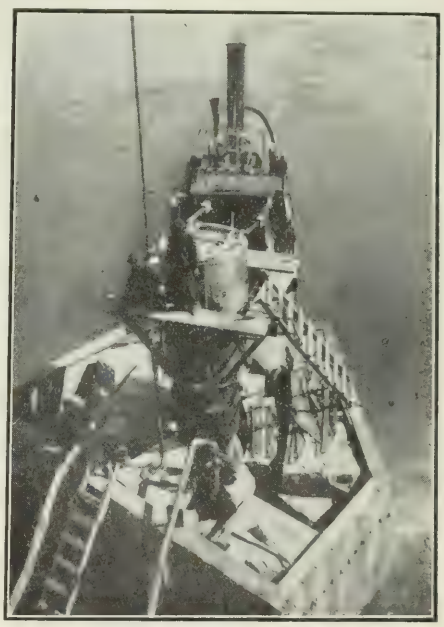
Material for piers Nos. 8 to 14 inclusive, was delivered to each pier from the south shore by means of scows and a tug. A large material yard with the necessary switching tracks connecting with C.P.R. main line and buildings built on south shore and a temporary deck built also.

Power house containing compressors, boilers, pumps and dynamo, was located on south shore. Air line was laid on old bridge.

The contractors for the substructure used the following plant on the job: 2 derrick scows, 1 concrete mixing scow, 7 material scows, 1 tug, 12 hoisting engines, 350 h.p. boilers, 2 concrete mixers, 12 derricks, 3 compressors, besides pumps, dynamo, etc.

Work was commenced in July, 1910, and finished December 1st, 1911.

The great difficulty in doing this work was principally in building and sinking caissons, and in moving scows, row boats and tugs around in the swift 10-mile current. The current was not uniform as the obstructions in the river made by the old piers produced a series of eddys, cross-currents and whirlpools. Even in deep water there were a lot of boulders lying near the surface. Operating floating equipment around in such a locality was an operation fraught with danger to both life and property.



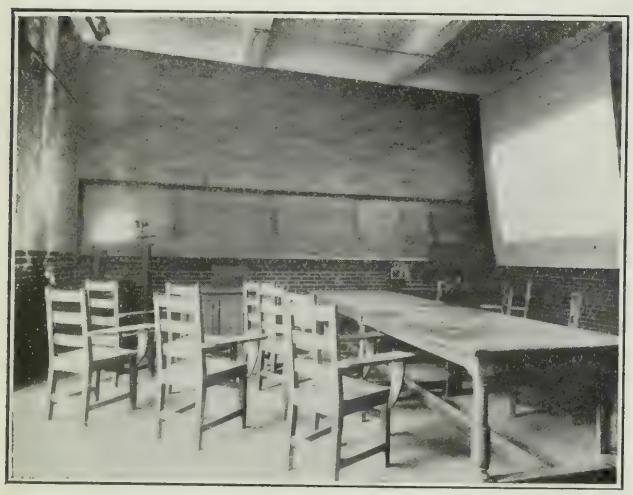
Sinking a Pneumatic Caisson at Down-stream End of One of Channel Piers.

The contract for the new substructure of the bridge was executed by The Foundation Company, Limited, of Montreal, under the supervision of Mr. J. M. R. Fairbairn, assistant chief engineer of the Canadian Pacific Railway. Mr. J. H. Barber was resident engineer on the work.

McGILL UNIVERSITY, COURSES IN THE FACULTY OF APPLIED SCIENCE.

By E. BROWN, M.Sc., M. Eng., Professor of Applied Mechanics and Hydraulics, McGill University.

The name of McGill University is known throughout the world, and not a little of the prestige of the city of Montreal is due to the great university, which occupies such a prominent position in its midst. The eminence of McGill in many branches of learning is well known to all our readers, but the work of the Faculty of Applied Science in training the young engineers who are going out to contribute to the progress of the Dominion is of special interest. The annual meeting of the Canadian Society of Civil Engineers, which takes place in Montreal shortly, will doubtless attract many of our leading engineers, and it seems appropriate to give some account of the work of McGill University in which they will find the greatest professional interest. We do not propose to give a history of the rapid development of the Faculty of Applied Science, interesting though that would be, nor to set forth the details of the numerous courses offered, but rather to explain in some measure the aims and objects of the training given, no matter what branch of the profession a student may enter. To this end it will be necessary to describe the training common to all courses, and then to proceed to show



Lecture Room, (Railway Department.)

its logical development in some special branch of engineering. Our readers will thus be able to realize more clearly the continuity of the work than if several courses were described inadequately. The particular features of the various specialized courses will be pointed out, after the general scheme of one course has been followed to its conclusion.

It is a striking feature of the work that the undergraduate body is drawn from all parts of the world, and this fact, in itself, bears eloquent testimony to the high position which the engineering school occupies in the academic and professional world. Of a total of 555 students enrolled in the present session, only 257 come from the Province of Quebec, and the remainder are distributed as follows: Ontario 108, Nova Scotia 17, New Brunswick 22, Prince Edward Island 11, Manitoba 12, Saskatchewan 5, Alberta 12, British Columbia 22, Newfoundland 4, England 31, Scotland, Ireland and Wales 2 each, British West Indies 15, United States 17, Mexico, Peru and South Africa 2 each, Republic of Colombia, Ecuador, Italy and Switzerland 1 each, unclassified 6. The graduates of McGill are likewise scattered all over the world, and occupy the highest positions in the profession. The name of McGill is thus widely known, and the courses attract not only those commencing their college training, but many who have graduated in other universities and find it advantageous to take an additional course of study and a degree in McGill University before commencing the practice of the profession in Canada. In this list may be included graduates of Cambridge, Edinburgh, Liverpool, Manchester and other well-known universities.

Courses of study extending over a period of four years and leading to the degree of Bachelor of Science are offered in the following ten subjects:—

Civil Engineering.
Electrical Engineering.
Mechanical Engineering.
Mining Engineering.
Railway Engineering.
Metallurgical Engineering.
Chemical Engineering.
Chemistry.
Metallurgy.
Architecture.

Seven of these subjects bear the distinctive title of "engineering," and in all of these the course of study is the same in the first two years. These courses will be considered first, and the courses in chemistry, metallurgy and architecture later. In all courses the work of the session extends from about September 1st to the end of April, thus leaving the summer months free for the student to engage in practical work.

Engineering Courses.—The fundamental principles underlying the various courses of study are as follows:—

(a) That a thorough grounding in mathematics, geometry, mechanics, physics, chemistry, and the elements of draughting, is essential to intelligent study in any branch of engineering, and in conjunction with the general and specialized work which follows, enables a student after graduation to adapt himself to the requirements of the various branches of the profession, if called upon to do so.

(b) That having had such a preliminary training, all engineering students require professional training in certain subjects, such as strength of materials, the elements of mechanical and electrical engineering, and surveying, coupled with specialized training which will fit them for some particular branch of the profession.

(c) That the professional training common to all branches of the profession should precede the specialized training of any one branch, so that the student may have as broad a view of these studies as possible, and that a considerable amount of time may be spent as continuously as possible in the specialized studies.

(d) That no subject of study in any course should be undertaken unless the student is properly qualified by previous study to appreciate the work, and to pursue it in a manner which will make it of real educational value to him, and not merely the opportunity for collecting a few disconnected ideas. This is ensured by a scheme of pre-requisites.

First Year Study (All Engineering Courses).—This includes algebra, trigonometry, geometry, mechanics, descriptive geometry, physics, English, freehand, mechanical drawing and shopwork.

Practically one-half of the total time is devoted to the first five of these subjects, these being regarded as of supreme importance in the course of fundamental training. The progress made in this work is tested from time to time during the first term, and although the final standing is not determined until the end of session, the regulations compel any student whose progress is unsatisfactory in any four of these subjects to withdraw from the faculty at the end of the first term. The class is thus freed automatically of any, who, either from incompetence or lack of application, are failing to profit from the instruction given, and are thereby imposing a needless burden, both on the instructors and on their fellow-students. The operation of this rule has a salutary effect and accustoms the class to the idea underlying the scheme of instruction as regards pre-requisite knowledge.

The course in physics, dealing with heat, light and sound, includes laboratory work, in which experiments, **mainly quantitative,** are made to illustrate the subject matter of the lectures. This is an important point, as engineering students spend much time in making quantitative measurements in the various laboratories, and in the practice of their profession. Such measurements are made frequently under difficulties and in circumstances in which errors must arise. It is well that in the preliminary scientific work a student should learn to appreciate the conditions for precise measurement, and to realize the relative importance of accuracy of measurement of the various quantities involved, in considering the probable degree of accuracy in the result they are seeking. Not only must an engineer know the probable degree of accuracy of his results, but he must be able to present them in a consise and accurate manner. The course in English composition is designed to stimulate ease and directness of expression, and in the preparation of reports on laboratory work carried out during the full course of study, and in the writing of theses on summer work, the student has an excellent opportunity for practice in the handling of available material. The course in English includes the reading of some five or six English classics during the first summer vacation, on which an examination is given on entering the second year.

The courses in shopwork, in the first and second years, are designed to give the student some working knowledge of materials and of methods of manipulation. Thorough manual skill can only be obtained by longer practice in engineering shops, but an endeavor is made to familiarize the student with shop equipment and methods, so that he may profit as much as possible by working in engineering shops later on. At the same time those who do not work in this way are not altogether devoid of sound ideas on such matters. Definite exercises are carried out in the first year course, in carpentry and wood turning, and in the smithing and foundry, and in the second year similar work is done in the metal workshop, and students are instructed in the use of the various machine tools, and in the preparation and care of tools.

The courses in freehand and mechanical drawing are designed to familiarize the student with sketching, and with the methods of preparing working drawings. Drafting room methods are explained and practice is given in the drawing of simple machine details, in lettering, and dimensioning of working drawings, etc.

After completing the course outlined above, the students leave about the end of April, the great majority obtaining work for the summer vacation. Some details of this work are given later, but it may be mentioned here that during last summer 85 per cent. of the students in Applied Science worked for an average period of 3.2 months.

All students entering second year courses are required to return to Montreal for the month of September to take a course of field instruction in the principles of surveying, as a preliminary to the work in that subject noted below.

Second Year. (All Engineering Courses).—The work in mathematics, mechanics, physics, mechanical drawing and shopwork are extended, the mechanical drawing course with a view to preparing the student for design work of the third and fourth years, and the shopwork as already noted.

In mathematics, courses in the calculus are given and are of the highest importance in the work of the year, being prerequisite to much of the late work. A course in analytic geometry is also given. The work in mechanics is done after progress has been made with the calculus course, and the work of the first year is extended to include many problems in variable motion arising in engineering practice. It may be pointed out that mechanics is taught as a separate subject through three years, and not as a part of the various professional subjects (such as mechanics of machines, dynamics of machines, strength of materials, etc.), to meet the bare requirements of any particular problem. The work is brought to bear directly on the professional subjects by carefully selected problems, and this adds interest to the work in mechanics, and minimises the amount of purely extraneous teaching in professional subjects.

The physics of the second year deal with the laws of electricity and magnetism, the laboratory work including quantitative measurements of magnetic fields, pole strength, current, resistance, potential, etc., and the calibration of measuring instruments. It thus provides the preliminary training required for a study of the elements of electrical engineering, which is taken as a part of the professional

Wood Workshop.

work by all students, for there is scarcely any phase of engineering activity at the present day, in which electricity does not play an important part.

The lectures and laboratory course in general chemistry familiarizes the student with the principles of inorganic chemistry, and gives some practice in qualitative analysis. It is desirable for all engineering students, and especially for those who intend to specialize in metallurgical, chemical or mining work. Concurrently with the chemistry course, a course on materials of construction is given, dealing with the principal methods of manufacture of steel, iron, the chief metal alloys, cement, etc. The uses of these materials, and of timber, masonry, etc., are considered, and some typical standard specifications are discussed.

As a preliminary to some of the third year work, courses in mechanics of machines and graphical statics are given.

The field surveying work carried out before the opening of session has been referred to above. It forms part of a

general course in the principles and practice of surveying, and includes the ordinary problems of chain surveying, the use of the level, theodolite, compass, etc. Detailed surveys are carried out and recorded, and the data so gathered are used in the preparation of detailed plans in the mapping course. The problems arising in ordinary practice are dealt with in a lecture course, and in this way a comprehensive idea is given of the field and office work necessary in the preparation of a surveyor's plan.

The students are again free at the end of April to take up practical work for the summer months, but are again required to attend a summer school course of four weeks before commencing the work of the third year. The work undertaken depends upon the branch of study which the student desires to enter upon, and is as follows:

(a) Field surveying for students in civil, mining or railway engineering.

(b) Mechanical drawing and design, physics, (including more advanced electricity and magnetism, and electrical measurements than that given in second year), and shop-work for students in electrical and mechanical engineering.

(c) Qualitative and quantitative chemical analysis for students in metallurgical engineering.

In addition to the above, all students are required to prepare an essay, preferably upon their summer work (or upon some prescribed subject), or to follow a course of reading in which an examination test is given. These essays are a distinctive feature of the work, and frequently reveal decidedly strong powers of observation. A similar requirement is exacted of students entering the fourth year, and many excellent essays result. Credit is given for excellence of material, successful presentation, originality, and literary style, and no essay prepared merely from books is accepted unless special permission has been granted. The high standard of many of the essays may be judged from the fact that very frequently a similar essay secures the prize given for papers presented by student members to the Canadian Society of Civil Engineers, the Canadian Mining Institute, etc. The class of work secured by students during the summer months and their ability to make good use of the opportunity afforded, are shown by the fact that it is no uncommon thing for a student to be refused permission to publish certain parts of an essay—such for example as cost data.

Mechanical Engineering Laboratory.

As an example of the summer reading prescribed instead of an essay it may be stated that Shadwell's "Industrial Efficiency" was the set book for the past year.

Third and Fourth Year Courses.—Having completed the above course, the student must choose some branch of engineering in which to specialize, and complete two years of further study. The whole of this time is not spent in specialized work, as all courses have certain professional subjects in common, such as strength of materials which is the basis of many calculations in all branches of engineering. The elements of mechanical and electrical engineering are also common to all courses. Alternative subjects are allowed in some fourth year courses. For example, one electrical engineer may wish to study electro-chemistry and electro-metallurgy, while another, more interested in power development, may wish to take up hydraulics. Provision is made for the exercise of such legitimate preferences, but the greater part of any course is fixed, so that a sound general training is assured. With seven engineering courses to be considered and many alternatives in each, it will be seen that no connected idea of the progress of the scheme of study can be given within reasonable compass, by attempting to describe all courses. Selection must be made, and for present purposes, the specialized work of the civil engineering student will be considered. The trend of the course of study in other branches will then be indicated.

The work of the civil engineer requires that he be specially informed upon such subjects as the strength and testing of materials, theory and design of structures, surveying, hydraulics, railroad engineering, etc., and the third and fourth year courses afford the training necessary.

Third Year Course (Civil Engineering).—An important part of the course is the study of strength of materials and the allied subjects of foundations and structural design, Lectures in strength of materials are given throughout the session, and laboratory work is added to familiarize the student with the various types of testing machines and method of testing. The students themselves carry out all the tests made to illustrate fundamental principles, and also make complete tests of cement, following standard specifications. They also witness demonstrations on the strength of timber beams, reinforced concrete, reinforcing materials, bricks, concrete, etc., and prepare reports on all laboratory work. (This course is taken by all engineering students.)

A lecture and draughting course in foundations runs concurrently with the strength of materials, work, and, as progress permits, simple designs are carried out. The graphical statics work of the second year is made use of in such problems as the stability of retaining walls. Practice is given in taking out quantities from working drawings and in preparation of cost data, and relative costs of alternative designs are considered in some simple cases. This work is only taken by civil engineering students, and is completed in the first term. The progress with strength of materials work then enables the course in structural engineering to be started, and this is also taken by all except electrical engineers. A combined lecture and draughting course deals with the design and structural details of columns and girders (as for a steel frame building), roof trusses, box and plate girders, reinforced concrete beams and columns, etc. Working drawings, with bill of materials, and cost estimates, in some cases, are prepared, and the student becomes familiar with much of the ordinary day to day practices. The course affords the necessary preliminary training for the more advanced design of the fourth year civil engineering course and gives to the students the necessary acquaintance with the elements of structural practice.

Another important group of subjects is surveying, railway engineering and mapping, for which the summer school work in surveying, already mentioned, is a prerequisite. This includes practice with and adjustments of level and theodolite, survey and location of a railway line; hydro-

graphic work, including measurement of river discharge; astronomical observations, etc. The data thus collected forms the basis of the subsequent mapping course in which the paper location of a railway line is drafted from the notes, maps and profiles are drawn, earthwork quantities taken out, etc. A yard and switch design is also made and drawn out. Concurrently with the mapping course and supplementing the work done in the field, lectures are given in railway engineering dealing with grade problems; effect of distance, grade and curvature on train-mile costs; economics of location; turnouts, yards, terminals, etc. The above work is taken by civil, railway and mining students. Students in the civil course take also a course of lectures in surveying dealing with the theory and use of instruments; mining, magnetic, hydrographic, trigonometric surveys; transition curves, etc.

Instruction is given in municipal engineering problems, and is continued in the fourth year. The third year work includes systems of removal and treatment of sewage; construction of sewers; field and office work in the preparation of plans, cost data, etc.; construction and maintennance of roads. This special work and that of the fourth year is in charge of an instructor engaged in municipal engineering practice.

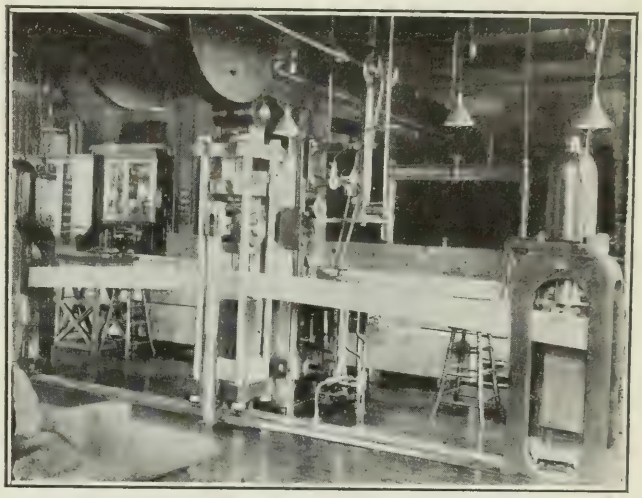
A course in mechanics dealing with the motion of rigid bodies is also given. Geology is treated in a course which is taken also by mining, metallurgical and chemical engineers. The course is a general one, including some mineralogy, and special attention is devoted to dynamical and historical geology and to the economic aspects of the subject. Field excursions are made in the neighborhood of Montreal, and practical instruction is given in the museums and by the aid of maps and models.

The remainder of the course includes (a) descriptive geometry dealing with perspective, plotting a photographic survey; spherical projection and map construction; (b) engineering economics including the subjects of money, credit, formation and organization of business companies, operating and fixed charges; specifications, contracts, etc.; (c) general course in mechanical engineering with laboratory work, dealing with the equipment and operation of power plants; (d) an optional course in differential equations.

The above concludes the work of the third year, and with the exception of elements of electrical engineering taken in the fourth year, along with electric railways, it may be said that the general professional work is completed, leaving the fourth year almost entirely free for more advanced study of those civil engineering subjects taken up in the third year, and for other specialized work. Summer work may again be obtained from the end of April to the end of August, the class being required to attend four weeks field course in surveying in September, after which the work of the final year of study commences. Students must also submit an essay of from 2,000-5,000 words, consisting preferably of a critical description of the work in which they have been engaged during the summer.

Fourth Year Course (Civil Engineering).—The specialized work of the final year falls into groups of subjects more or less related: (a) Theory and design of structures; (b) surveying; (c) hydraulics and municipal engineering (water supply); (d) railway engineering and electric railways, and a general course in elements of electrical engineering. In the theory and design of structures, the aim is to explain the fundamental principles of the determination of stresses in various types of structures, to apply the principles of strength of materials to the computation of the necessary dimensions of the main members of structures, and to develop a considerable knowledge of the detailing in design work. To this end, lecture and draughting work is taken concurrently, the latter bearing directly on the former, and as the work progresses designs for selected types of bridges are worked out in considerable detail, and working drawings are prepared. A large part of the time available is devoted to this form of practice, as it is thought that a sound knowledge of bridge design evolved from fundamental principles is the most suitable form of training for the whole field of structural design. A course in reinforced concrete dealing with the design of floor and column units for a large building, retaining walls, arches, etc., is also given, and includes draughting room work and laboratory tests on reinforced beams.

The work in surveying carried out in the summer school includes astronomical observations for latitude and longitude; base line measurements; precision levelling, special problems in track work, etc. This is followed by a course of lectures dealing mainly with the reduction of astronomical observations, measurement of base lines, large triangulation surveys, etc., and by a laboratory course in which instruction is given in the determination of errors and constants for surveying instruments in general. This completes the comprehensive course in surveying work which commenced in the second year.



Testing Laboratory, Beam Under Load in Wicksteed Testing Machine. Capacity 200,000 lbs.

In the hydraulics course the fundamental principles are developed and applied to problems on the flow over weirs, in pipes and open channels.. Turbines, pumps and other hydraulic machines are considered, the endeavor being in all cases to treat the problems from elementary principles, which enable the characteristics of various types to be understood. Concurrently with the lecture course a series of laboratory tests is carried out to illustrate the more important principles of the subject. The work of the municipal engineering course deals with problems in water supply and includes discussion of rainfall, evaporation, works for storage and distribution; purification; calculations for systems of supply mains, preparation of plans, costs, etc.

Problems in railway engineering practice which border on civil engineering work are dealt with, and include the organization of an operating department, construction, maintenance, renewals, train service, signalling, etc. The course supplementing the work of the third year in railway location, etc., gives a good foundation for more extended study, if a student is thrown into contact with such work.

A course in engineering law is given, the object being to present such an outline of the law as will be useful to engineers and business men. The main topics discussed are the general law of contracts; law of architect and

builder; statutes affecting labor; commercial paper; sale; lease; agency and partnership; joint stock companies; insurance carriers by land and sea. All students in the Faculty except electrical engineers take the lectures either in their third or fourth year course.

The remainder of the course is electrical in character and includes a series of lectures on the principles of direct and alternating current machines, systems of distribution of power, lighting, traction, etc. A laboratory course is given to supplement the lecture work, and when some progress has been made with the subject, a course in railway engineering dealing with the equipment, maintenance and operation of electric railways is added.

The student who passes successfully through the course described is granted the Degree of Bachelor of Science in Civil Engineering. It will be seen that a continuous endeavor is made to give a sound general scientific training, introducing specialization to a sufficient extent to ensure that a successful student may enter on the practice of the particular branch of the profession in which he has studied, well equipped to avail himself of the opportunities offered. At the same time the general training given is sufficiently broad to give him a good grip on subjects outside the strict limits of his own special branch of work, and to enable him to deal intelligently with problems in other branches of engineering which inevitably arise in the practice of any particular branch of the profession.

Specialized Work in Other Engineering Courses.—The above account of the work of the civil engineering course illustrates the principle underlying the development of the courses of study in all branches of engineering. After the training of the first and second years, which is the same for all students, and is mainly of a mathematical and general scientific character, the third year study includes professional work common to all students, viz., elements of mechanical and electrical engineering, structural engineering, strength of materials, etc., and some specialized work, professional or scientific, leading up to the more advanced work of the fourth year. The differences in training noted in connection with the summer school work, preceding entry to the third year, emphasise this specialization. We may note briefly some of the principal features of courses other than the civil.

On entering the third year the electrical student continues his study of physics, takes a more complete course in the elements of electrical engineering than that given to the general body of students, studies machine design instead of structural design, and if he is contemplating specializing in electro-chemistry and electro-metallurgy in his fourth year, an introductory course in this work is prescribed for the third year. Following this specialization the work of the fourth year develops along the same lines.

The student in mechanical engineering prepares for the specialization of the fourth year by taking a more complete course in mechanical engineering than that given to the general body of students, and studies problems in mechanism, thermodynamics, machine design, shop processes, etc. In the fourth year more advanced work follows, and such subjects as manufacturing, plant design, heating and ventilation, locomotive engineering, works organization, and accounting may be studied.

Metallurgical and mining students prepare for their fourth year by taking courses in quantitative chemical analysis, mineralogy, geology, and the subjects of ore dressing, fire assaying, metallurgy, and general mining are commenced, and are more fully developed in the fourth year. A special feature is the field class in mining, which all students of the course must attend. This consists of a six weeks duration, following the close of the third year work in college, and places of professional interest are visited, the party being in charge of the staff of the mining department. Time is devoted to geological field work, mining work proper, and to an examination of ore dressing and milling plants. It may be of interest to note that these parties have visited at various times British Columbia, Nova Scotia, Pennsylvania, Newfoundland, Michigan, and numerous places of interest en route to these distant points.

Metallurgical engineering students make similar visits to manufacturing plants in Montreal and at a distance, and a short lecture course is given in exvlanation of the processes to be studied.

The course in chemical engineering is designed to prepare the student for the duties of a managing engineer in a chemical factory. He must have some general engineering training and be conversant with chemical processes. The course includes the general work specified above for all engineering students, and a special summer course in chemical analysis precedes entry to the third year. Other subjects of study include geology, metallurgy, organic and inorganic chemistry and industrial processes with special reference to the branch of work to be taken up. Between the third and fourth years at least six weeks must be devoted to suitable work in a chemical factory or to equivalent laboratory work in the university.

Courses in railway engineering prepare students to enter (1) the operating department or executive offices; (2) the mechanical department; (3) the engineering department.

The Canadian Pacific, Grand Trunk, Canadian Northern and Intercolonial railways contribute to the support of the work of this department. Arrangements exist whereby students may enter the employment of a company during summer vacations as special apprentices. They thus acquire, under the direction of the officials of the company, a general experience which will fit them to fill higher positions after successful graduation. Full particulars of these arrangements are given in the Bulletin of the Department of Railways.

Students preparing to enter the mechanical department follow the same course as mechanical engineering students, but make a special study of locomotive construction and operation as part of their specialized work. Those entering the engineering department take the regular civil engineering course, but are required to engage in practical railway work during the summer months under the direction of the department of railways.

The operating and executive course includes, in the third or fourth year course of study, much of the general work common to all engineering courses (strength of materials, electrical and mechanical engineering, etc.). In the third year includes a more advanced course in economics than that given to the general body of students, and this is followed by a special course in railway economics in the fourth year. Courses in engineering law and in railway law are also given, and courses in English afford practice in the preparation and criticism of reports on stated subjects. Railway organization and accounting, freight and passenger service, and telegraphy are dealt with by officers of the railway companies engaged in these departments of work, and the course also includes instruction in railway mechanical engineering (locomotive design, operation, etc.), railway engineering (grade problems, train costs, economics of location, layout of terminals, yards, etc., organization of operating department, construction and maintenance of way, etc., etc.); railway operation and systems of signals; physical geography and shorthand.

The work of the department is developing steadily, and while it is not numerically as large as many of the older de-

partments, the success attained by many of its graduates who have entered the service of the companies which are co-operating in the work, proves that the work is developing along sound lines, and that the course affords the opportunity for efficient training along specialized lines outside the older recognized branches of the profession.

Courses in Chemistry and Metallurgy.—These differ from the chemical engineering and metallurgical engineering courses in that they are intended to train men for the purely scientific side of such work, i.e., to become analysts, or chemists, or metallurgists in a manufactory. Such engineering subjects as strength of materials, mechanical and electrical engineering, etc., are not taken, and the time devoted to these in the engineering course is given to more advanced study in chemistry and metallurgy. The general preliminary training resembles that of the engineering student, but the specialized work is purely scientific.

Course in Architecture.—Four years of study in the Department of Architecture lead to the degree of Bachelor of Architecture, and an increasing number of students are availing themselves of the facilities offered to secure a thorough grounding in those principles of architecture which tell later on in a professional career. The work done is also recognized by the Province of Quebec Architects' Association in that a graduate in architecture will be admitted to practice in the province, after spending one year in the office of a member of the association, and passing an examination in design. This office work may be made up of instalments during the summer vacations. The training also prepares the student for the examinations of the Royal Institute of British Architects.

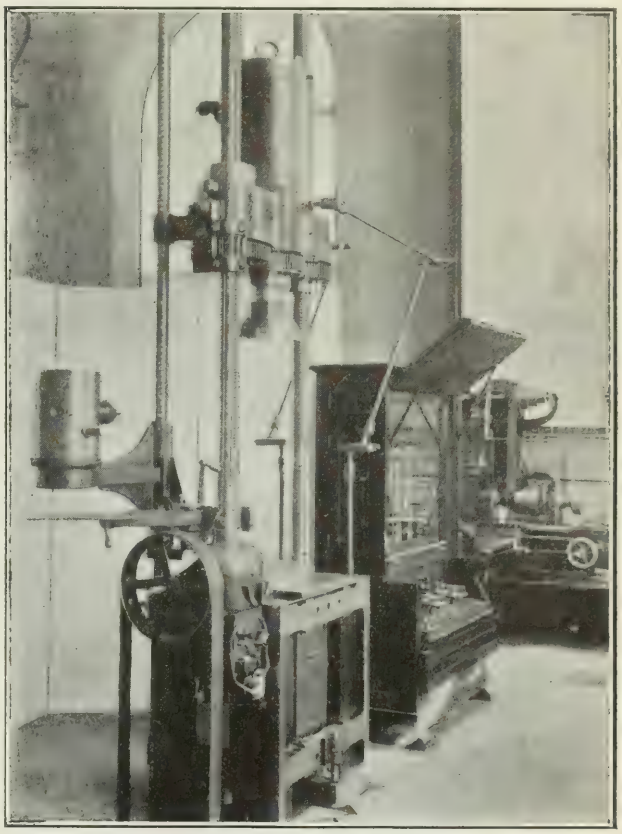
The course is under the direction of the Faculty of Applied Science, but in the first two years general culture courses in history, French, physics and mathematics are taken in the Faculty of Arts. Geometry and English are taken with the first year students in Applied Science and the professional work of the first year includes freehand and architectural drawings, modelling, and the elements of architecture. This work is intended to give the student practice in draftsmanship, and teach him the basic principles of design. Freehand and detail drawings are made of recognized types of forms and architectural details. The student is thus prepared for more specialized professional work of the second year in which design is given a prominent place.

Mathematics and general history are continued in the second year, and the courses in surveying, mapping, and graphical statics of the second year engineering course are included. The architectural work includes lectures and draughting practice in the following: Building construction and details; architectural history; ornament and decoration; modelling; theory of architecture. Continuous practice is given in the draughting room in the development of the principles explained in the lectures, and this is facilitated by the large number of reference books, etc., which are available. The reference library of som 300 selected books adjoins the draughting room, and the equipment of the department also includes some 2,500 large photographs, 5,000 plates and nearly 3,000 selected lantern slides. These are available for reference at all times.

The third and fourth year courses are almost entirely professional. Geometrical drawing and perspective are continued, and the course in engineering law previously referred to is included. Courses are given in graphical statics, structural design and details, hygiene, ventilation and heating, etc., and the architectural work includes theory of design and planning; history of architecture; ornament and decoraton; architectural practice and modelling. The draughting room work includes problems in composition requiring different treatment, and of increasing difficulty. In the latter part of the course a series of planning problems are set, some of which are worked out in detail, and the diploma design for graduation occupies the work of one term.

The summer vacations extend from the end of April to the end of September, but students entering the second year course are required to attend the field work in surveying during the month of September.

Instead of writing an essay, as prescribed for engineering students, students in architecture are required to read and pass an examination on certain books. The prescribed books for the past summer for students entering second year were "The Mistress Art," Reginald Bloomfield, and "Essentials in Architecture," by John Belcher. For third and fourth year students "The Mistress Art" and "Memories of Benvenuto Cellini" were prescribed.



Testing Laboratory. Emory Testing Machine. Capacity 150,000 lbs.

In addition to the above, students must either spend at least five weeks in the employ of an architect or contractor, or submit thirty-five free hand drawings of reasonable size. During the past summer 80 per cent. of the students worked for from three to four months in architects' offices or with contractors, and thus on graduation many will be ready for admission to the Architects' Association of the province.

Summer Employment.—The following information regarding summer employment may be of interest: All students entering the second, third and fourth years are required to state the nature and duration of their summer work. The information is not asked from the first year class, as they have not had any previous connection with the faculty.

The returns for the past summer show that 298 out of 350 students were engaged in summer work. Of these, 13 worked for one month or less; 62 for two months; 18 for 2½ months; 76 for three months; 24 for 3½ months; 78 for four months, and 27 for five months. This gives 85 per cent.

of the students engaged in practical work for an average of 3.2 months each. The varied nature of the work obtained is shown by the following return of the number of students engaged in different classes of work: Mining and geology, 32; surveying, 53; prospecting, 3; draughting and design, 21; machine shops, 48; construction and general contracting, 48; electrical work, 31; metallurgy, 4; chemistry, 7; architecture, 13; office work and railway operating, 30; farming and lumbering, 6; military work, 2.

The programme of the meeting of the Canadian Society of Civil Engineers, in Montreal, from January 24th to 26th, includes a reception by the president and members of council in the Engineering Building, which has been placed at the disposal of the society by the University authorities. The laboratories and workshops will be open for inspection, and no doubt the members of the society will avail themselves of the opportunity of becoming acquainted with the equipment of the faculty, whose work has been described above.

HIGH-HEAD REACTION TURBINES BUILT IN MONTREAL.

The Canadian Society of Civil Engineers will have an opportunity of examining the details of construction of high head reaction turbines during the annual meeting in Montreal. Allis-Chalmers-Bullock, Limited, is the only firm in Canada which builds turbines of this character, and has lately worked out some interesting features. Among the hydraulic turbines now under construction in the shops in Montreal are the following for Price Bros., Limited:

Four turbines in spiral casings, each 4,000 h.p., 225 r.p.m. under 264 feet head for driving pulpwood grinders.

Two turbines in spiral casings, each 3,350 h.p., 600 r.p.m. under 264 feet head, for driving electric generators.

Two turbines in spiral casings, each 600 h.p., 1,000 r.p.m. under 264 feet head, for driving centrifugal pumps, with governors, valves and other auxiliary apparatus.

The accompanying illustrations show many of the details of this style of turbine. The runners are always designed specially to meet the requirements which the conditions call for, and, whenever possible, are made of bronze cast in one

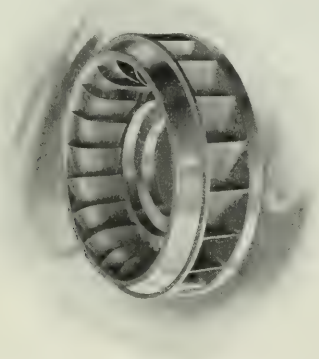


Fig. 1.—Bronze Runner.

piece, as shown in Fig. 1. The runner is bolted to a forged flange or steel hub, (shown in Fig. 2) and only machined steel bolts are used in reamed holes, to make the construction "fool proof" and safe. The guide vanes shown in Fig. 3 are made of forged steel in one piece, are made to gauge, and are interchangeable. Both runners and guide vanes are carefully machined and polished all over and all rotating parts are balanced by static and running methods. Every spiral casing is provided with a "speed ring" (shown in Fig. 4) made of cast steel. This ring is rigid in constructon and

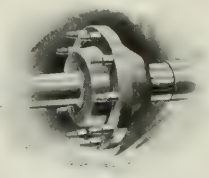


Fig. 2.—Forged Flange.

Fig. 3. Forged Steel Guide Vanes.

is designed to guide the water properly from the casing to the guide vanes and runner.

On all turbines with spiral casing the gate rigging (shown in Fig. 5) is arranged outside, so that it may be attended to without any interruption of operation. All bearings are lined with the highest grade babbitt, and are care-

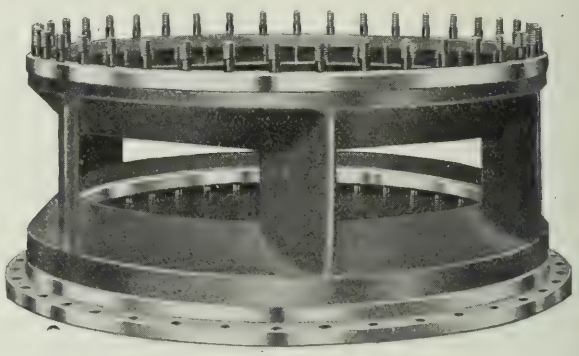


Fig. 4.—Cast Steel Speed Ring.

fully scraped to fit the shaft. The covers for places where water and moving parts come into contact are bronze or steel lined and machined accurately to gauge. Every turbine,

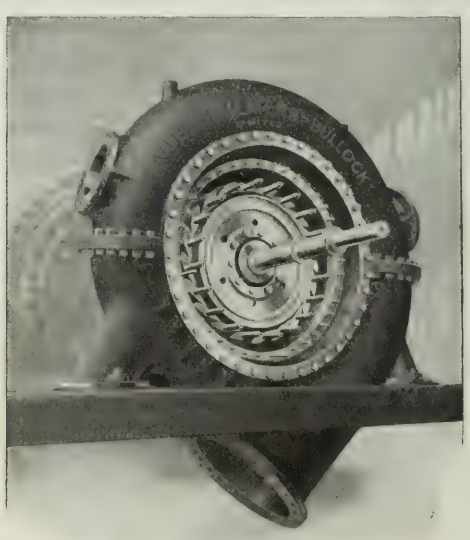


Fig. 7.—Guide Vanes and Runner in Position Within the Casing.

before shipment, is completely assembled in the shop and subjected to an overspeed test, as shown in Fig. 6.

This company has also developed a new oil pressure turbine governor. (Shown in Fig. 5). This governor is pro-

vided with all the modern appliances to make a quick and sensitive regulation possible.

The governor is of the self-contained type, and is designed for any operating conditions. Runaways are not possible with this design. The hand power control is combined with this governor and is ready for connection at any moment, without loss of time. No gears or racks of any kind are used with this governor. The oil pump is of ample capacity and well proportioned to operate without wear and tear. The space occupied for any setting is not more than four feet square. The governor body is of heavy design and neat in appearance. All enclosed parts are easily attended to during operation. The flyball is of the strongest possible design, and its construction is such as to make it one of the most sensitive on the market. The connection of this governor to the turbine is of a very simple construction. The governor is designed in such a way that the turbine gates can be operated either:

1st—By governor operated.
2nd—By hand hydraulically.
3rd—By hand mechanically.

These three operations can be changed at a moment's notice by touching one lever.

There was an impression for many years that it was necessary to go to Europe for high-class hydraulic turbines of this class, but Allis-Chalmers-Bullock, Limited, has shown

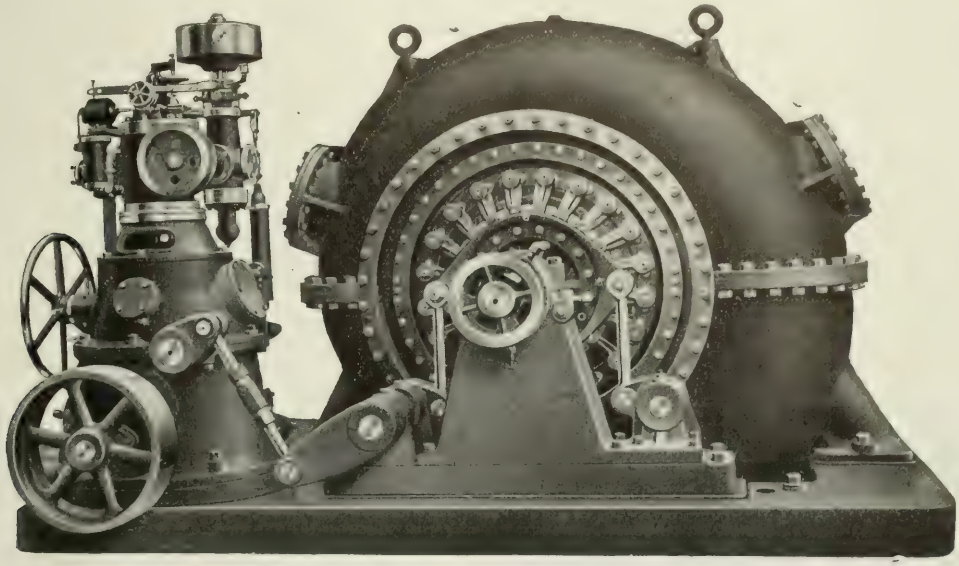


Fig. 5.—New Oil Pressure Governor and Outside Gate Rigging.

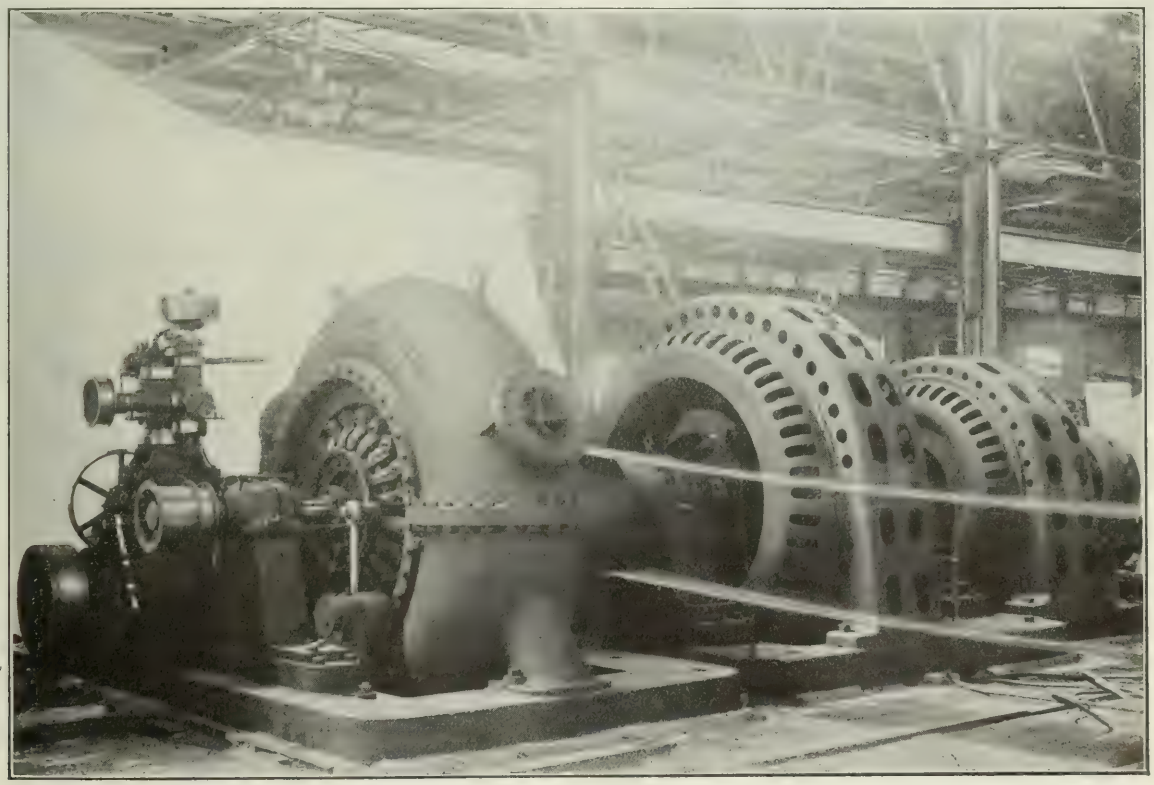


Fig. 6.—1,600 h.p. Turbine Motor Generator Set under Runaway Speed Test in the Shops Before Shipment.

that this is no longer the case. In fact the efficient design and thorough workmanship shown in the turbines which they have built have recently kept in Canada orders which formerly went abroad.

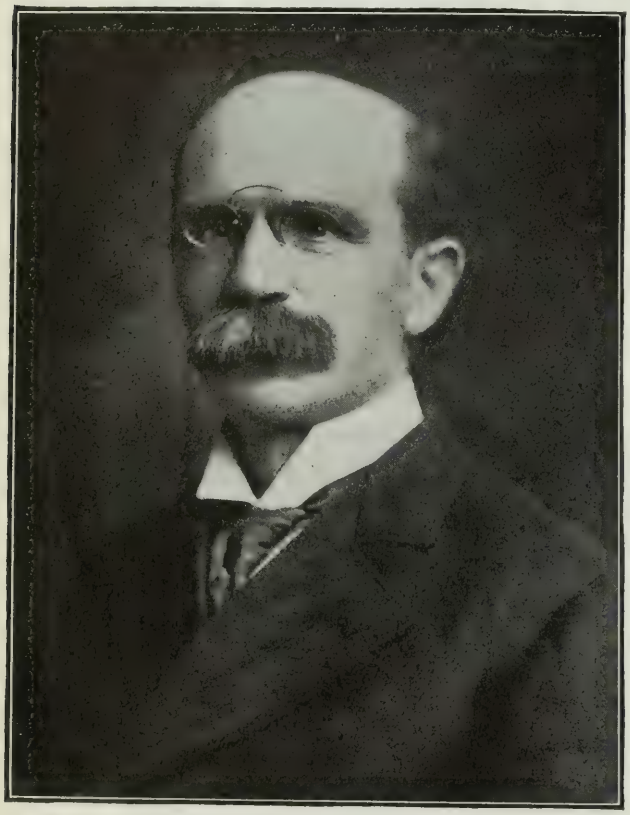
CANADIAN SOCIETY OF CIVIL ENGINEERS.

By E. A. James, B.A.Sc.

This year the Canadian Society of Civil Engineers held their annual meeting in the city of Montreal. Ever since the society was organized Montreal has been the home of the head office.

The objects of the society are to facilitate the acquirement and interchange of professional knowledge among its members and to encourage original investigation.

The term "Civil Engineer," as used in this society, means all who are, or have been, engaged in the designing



MR. C. H. RUST,
City Engineer, Toronto, and President of the Canadian Society of Civil Engineers.

or constructing of railways, canals, harbors, lighthouses, bridges, roads, river improvements or other hydraulic works, sanitary, electrical, mining, mechanical or military works, or in the study and practice of navigation by water or air, or in the directing of the great sources of power in nature for the use and convenience of man.

The society consists of honorary members, members, associate members, juniors, students and associates, and was organized in 1887, having now a membership of over 2,700.

Mr. C. H. McLeod is secretary of the society, and headquarters are situated at 413 Dorchester Street West, Montreal.

During recent years there has been a movement among the members to encourage the establishment of branch societies. It was expected that each branch would have their own society quarters, library, reading room and weekly or monthly meetings. The movement was a popular one and already there are branches at Quebec, Toronto, Manitoba, Vancouver and Ottawa and steps have been taken to organize at least three more branches at other centres.

The forming of branch societies is the natural outgrowth of increased membership, and another evidence of strength and increased membership is the raising of standard of entrance. From year to year the council of the society have been more exacting than the year before and in the amendment submitted this year, still more exacting requirements are being inserted.

The steady upward movement in the qualification for admission does not indicate that the society are unanimous in wishing to make a close corporation, but rather that they recognize the responsibility which they are undertaking when they attempt to give status to members of the engineering profession who identify themselves with the organization.

The present qualification for election to membership is as follows:—

Honorary members shall be distinguished men, eminent in engineering or kindred sciences.

Every candidate for election as member must be at least thirty years of age, and must have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in some school of engineering recognized by the council. The term of twelve years may, at the discretion of the council, be reduced to ten years in the case of a candidate who has graduated in an engineering course. In every case the candidate must have had responsible charge of work for at least five years, and this not merely as a skilled workman, but as an engineer qualified to design and direct engineering works.

Every candidate for election as an associate member must be at least twenty-five years of age, and must have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in some school of engineering recognized by the council. In every case the candidate must have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years.

Every candidate for election as junior must be at least twenty-one years of age, and must have been engaged in some branch of engineering for at least four years. This period may be reduced to one year, at the discretion of the council, if the candidate is a graduate of some school of engineering recognized by the council. He shall not remain in the class of junior after he has attained the age of thirty years.

Every candidate for election as student must be at least seventeen years of age, and must present a certificate of having successfully passed an examination equivalent to the final examination of a high school or the matriculation of an Arts or Science course, and must be pursuing a course of instruction in some school of engineering recognized by the council, in which case he shall not remain in the class of student for more than one year after graduation; or be receiving a practical training in the profession, in which case he shall not remain in the class of student after he has attained the age of twenty-three years.

Every candidate for election as associate shall be one who by his pursuits, scientific acquirements, or practical experience is qualified to co-operate with engineers in the advancement of professional knowledge.

Engineering ethics is a question every engineer has to consider at some time or other. It may be that he debates the subject with himself or he may discuss it with other engineers.

The code of ethics assembled by the Canadian Society of Civil Engineers is a good one, and as the membership

approaches closer to both the spirit and letter of this code, the standing of the society will be improved and its influence increased.

The code of engineering ethics as given in the publications of the society is as follows:—

Every member of the society should perform the work he undertakes to do to the best of his ability and in the true spirit of his engagement, feeling it to be his duty to present all ascertained facts in their true light.

The civil engineer has a right to expect from his client the same consideration and deference to his opinion as is by their clients accorded to the members of other professions—law and medicine, for example—and without which the adviser should decline to advise. The surest way for the engineer to obtain such necessary consideration and deference from the public will be found in his manner of carrying himself.

The assistant engineer must loyally obey and support his chief, to whom it will be his duty to report directly on all matters relating to the work on which they may be jointly engaged. His report should be full and explicit on all important points, and exact to the best of the assistant's knowledge and belief, cloaking nothing, even though going to show that previous reports had been inaccurate or not duly weighed, in some particulars affecting the well being of the business in hand.

The assistant engineer is entitled to look to his chief for, and to receive from him, advice for his guidance in the proper performance of his duties, and, where right, to expect his support in matters in dispute between him (the assistant) and his subordinates, or between him and the contractors working under him. He is also entitled to the aid of the chief engineer's professional experience or counsel where unlooked-for or extraordinary difficulties present themselves, or changes of original plan may be called for in the work on which they are associated, so that responsibility may be fairly apportioned between them.

It is the duty of both chief and assistant, each in his department, to study proper economy in the doing of the work, the management of which they have undertaken, and in every way consistent with the maintaining of the good character of the work to make the client's interest the guiding object.

The engineer may legitimately suggest experiments with a view to improvement, whether in methods of doing the work which he oversees, or for raising its character; but such experiments should only be undertaken with the full consent and co-operation of the person, whether client or contractor, on whom the expense may fall, and on the understanding that to them will accrue all pecuniary benefit from the success of the experiment.

It shall be considered unprofessional for any member of this society to seek the position of an expert to report on any work that is in charge of a recognized engineer.

It shall be the duty of any engineer, before examining any work with a view to report thereon, to give the engineer due notice before going on with the investigation in order that he may have every facility to explain and sustain his methods of carrying on the work in question.

Interchange of professional assistance between members, as tending to promote fraternal intercourse and mutual goodwill, is not to be discouraged, but neither is it to be considered obligatory on a member to respond to the request of a fellow member for professional counsel or assistance. Service so rendered must be entirely voluntary on the part of the member whose aid is sought.

The civil engineer may, consistently with professional status, take out patents for new inventions or for improvements on old ones, and may sell or otherwise dispose of the patents for his own advantage. He may undertake surveys and the engineering of works by contract, or he may take contracts for the construction of works on a percentage of their cost. Advertising with a view to attracting business should, where resorted to, be as far as possible free from egotistic or self-laudatory references, and expressed in language not derogatory to the dignity of the profession.

The civil engineer, whose advice is sought in respect to the usefulness, practicability, and cost of work, should, before expressing his opinion, obtain reliable information on all points involved in the matter submitted to his judgment, including the probable paying capacity of the contemplated undertaking. He must be cautious how he recommends large preliminary outlay, should avoid connecting himself with schemes or projects of merely speculative character, always bearing in mind that his professional reputation will be to a great extent judged by the inherent merits and commercial

COL. H. N. RUTTAN,
City Engineer, Winnipeg, and Immediate Past President of the Canadian Society of Civil Engineers.

value of the undertakings with which his name may come to be associated.

The Canadian Society of Civil Engineers contains among its members leaders in every branch of engineering in Canada. Each year membership in the society is more eagerly sought, and in four years the society should double its membership and quadruple its influence.

NOVA SCOTIA MANGANESE.

Much interest is shown in the new manganese mine at New Ross, Lunenburg, N.S. For upwards of a year, the work of development has been going on, new buildings erected and machinery installed for fitting the ore, which is of a very high grade, for the consumer. In a few weeks the company will be in a position to market the finished product in quantities. In this mine the manganese occurs in fissure in the granite, and in this respect is unique It has been practically proven that the product is eminently suited to the requirements of the glass makers and varnish manufacturers, as apart from its high chemical grade, its physical characteristics give it a long-continued high efficiency.

THE BUILDINGS OF McGILL UNIVERSITY.

By T. W. LUDLOW, B.Sc., M.A., Professor of Architecture, McGill University.

McGill University, like all the older seats of learning on this continent, owes its foundation to a private endowment. The Honorable James McGill, who died in 1813, bequeathed his property of Burnside, consisting of forty-six acres of land, with the dwelling house and other buildings, and a sum of £10,000 in money to found a college, in a provincial university, the erection of which had already been provided for by the British Government. Owing, however, to a disagreement among the trustees, the idea of a provincial university was abandoned; but application was made at once for a Royal Charter for the independent establishment of McGill College, along the lines laid down in the bequest. The charter was granted in 1821, and the Royal Institution for the Advancement of Learning, a body which was incorporated in 1802 to encourage universal education in the province of Quebec, proposed to take possession of the estate. Owing to protracted litigation, this was not surrendered to them until 1829, when the work of teaching was begun in two faculties, Arts and Medicine. The record of the first thirty years of the University's existence is an unbroken tale of financial embarrassment and administrative difficulties, and, with the exception of the Medical Faculty, became almost extinct as a body. In 1852 a revised and less wieldy charter was secured, and in 1855 a new era of progress and prosperity opened.

This second period of the University's history, that is from 1855 to the present day, may properly be called the formative period, as it has been marked by a very rapid growth both in aims and teachings of the institution, an expansion in all branches of learning, the establishment of new faculties (Law in 1853, Applied Science in 1878, and Agriculture in 1907), and the erection of new and modern buildings in which to properly carry on the work of instruction; so that to-day, with fourteen buildings, without counting those of the Agricultural College at Ste. Anne de Bellevue or the affiliated Theological and other schools, brings the University to the dawn of an era of maturity.

The fourteen buildings under discussion are:—

Molson Hall or the Arts Building.....1862
Peter Redpath Museum 1882
Macdonald Physics Building 1893
Redpath Library 1893
Macdonald Chemistry and Mining Building 1898

Molson Hall, or The Arts Building.

Royal Victoria College 1899
Strathcona (Old) Medical Building 1901
Conservatorium of Music 1904
Macdonald Engineering Building (New) and
Workman Engineering Building .....1893 to 1907
McGill or Students' Union 1907
New Medical Building 1911
Observatory.....
Strathcona Hall (Students' Y.M.C.A.).....
Power Station .....

The above buildings divide themselves, architecturally, into three groups, which reflect the prevailing taste at the time when each of the structures was built. These are:—

1. The Greek Revival or Neo-Grecque.
2. Romanesque.
3. The Early Renaissance of Elizabeth's England.

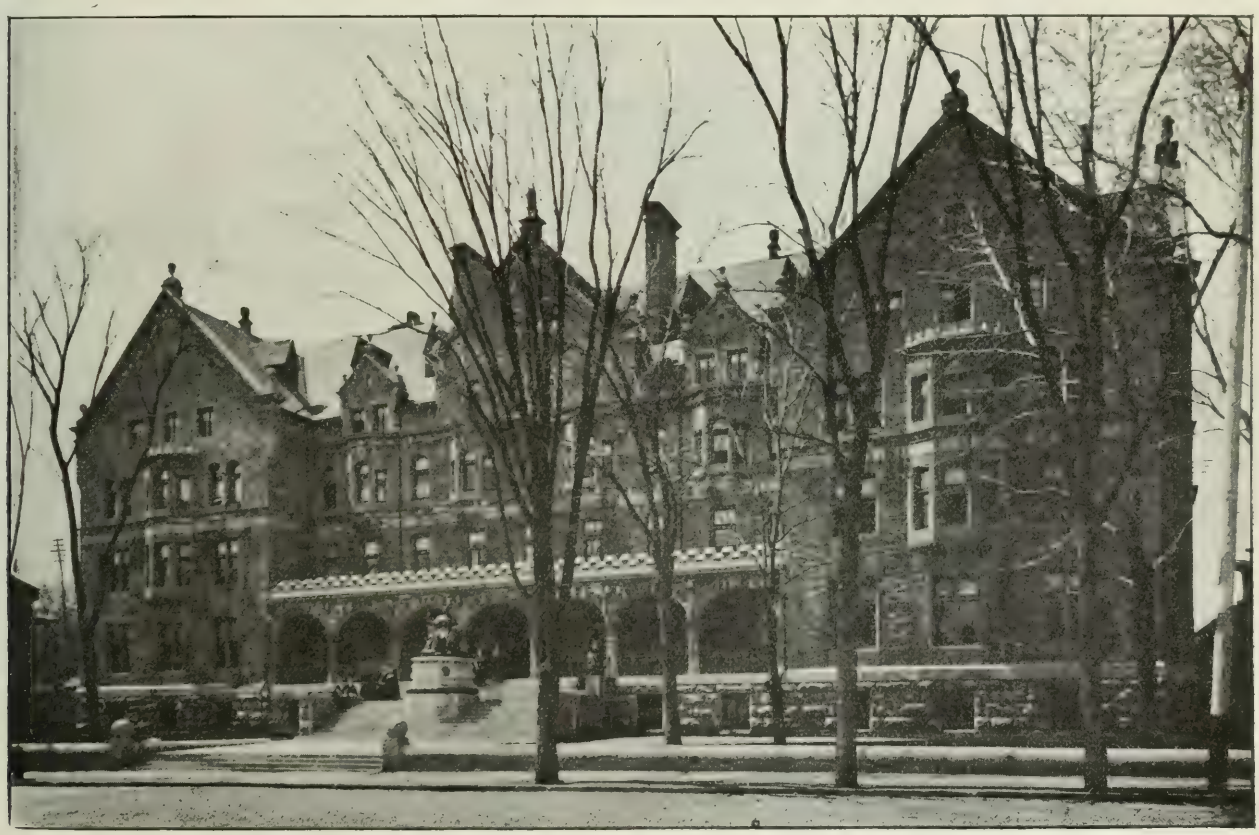
The Greek Revival is a recognized style in the history of architectural development, that owes its origin to the rediscovery of Attic forms by Messrs. Stuart and Revett in the first half of the XVIII. century. The character of the other two groups is based on the modernization of historic forms to suit present day conditions, and they are considered rather in the light of adaptations than styles.

To the first group belong Molson Hall and the Redpath Museum, the two oldest buildings of the University. The older of these, Molson Hall, is, with possibly the exception of the New Medical Building, the finest of all McGill's structures. This Hall is a long, low edifice with a commanding situation on the side of a hill, closing the long vista at the end of the shady driveway from the main entrance to the college grounds on Sherbrooke Street. It consists of a central and two end pavilions of three stories each and connecting wings, joining them two stories in height. The whole is built of local gray stone, which is so admirably suited, from the aesthetic view point, to the low color tones of Montreal's atmosphere. The central pavilion is naturally the focal point of interest; it consists of a very nicely proportioned, cubical building, crowned with a low roof, above which rises a well-arranged lantern. A porch of four Greek Doric columns, supporting the entablature, that does not follow too closely classical traditions and a very low pediment, forms the main entrance to the building. This feature is raised on a high base, and is approached by an imposing ramp of steps, equal in width to the porch itself. The arrangement of the end pavilions and connecting wings shows the same dignified simplicity that marks the central motive, they also show an interesting variety of treatment of window openings, that harmonizes perfectly with the main lines of the composition, yet differ materially one from the other. This is an excellent expression of true symmetry, one where the main masses agree, considered in relation to a central axis line, yet they are sufficiently varied in their individual parts to place this structure in a class above the so-called symmetrical buildings that are characterized by a repetition of parts. Unfortunately, as much cannot be said about the interior.

Directly in front of Molson Hall, situated on a plot of grass at the head of the driveway, is the burial monument of McGill's founder. It was moved to its present suitable location, together with the earthly remains of the Hon. James McGill, from the Protestant Cemetery in 1875. The monument is late Georgian in style and possesses all of the delicacy, charm and quaintness that characterized the funerary architecture of that period.

The second building of this group, the Redpath Museum, was built some twenty years later than Molson Hall, and its style reflects the change of taste even in that short decade. The treatment lacks entirely the vitality of the older structure. Here the front consists of a high central bay flanked on either side by lower wings, in much the same manner as the nave and side aisles of a church. The whole structure is raised on a high base and is approached by a broad flight of steps; above the base the facade is divided into two parts, a low one and a higher one above it. The main entrance is through a doorway in the central bay, above which there are two Corinthianesque columns in antis; this feature is crowned by a pediment. From the decorative point of view this edifice is particularly unfortunate, as the architect was evidently laboring under the impression that all that was necessary to make a good building was to use on a naturally limited surface all of the ornamental forms that he knew, as here one sees, especially on the main front, the whole grammar of classical Greek and Roman motives used indiscriminately, alike as to position, fitness and scale.

The Library, Chemistry and Physics Buildings form the Romanesque group, and they are all the work of Mr. Andrew



Royal Victoria College for Women. Mr. Bruce Price. Architect.

T. Taylor, who for many years was a leading practitioner in Montreal. He may briefly be summarized as a decorative architect, that is, one who designs his buildings around decorative forms, instead of having them grow out of a logical arrangement of parts. This must not be taken in the light of a severe criticism, as Mr. Taylor's work possesses many good points beside a charming decorative arrangement of the exterior.

The Library is the most worthy of this trio of buildings. It, like Mr. Taylor's chief works, is in a style adapted from the rich Romanesque of Southern France, which is known by its picturesque grouping of masses, low circular headed openings, a pleasing arrangement of doors and windows, and interesting decorative details. All of these features are well emphasized in the building under discussion, which has for its focal point a richly proportioned tower on the north front, on either side of which there are two wings, the one to the east containing the main reading room, while the one to the west houses several special reading rooms and the administrative offices. Stretching off to the south, back of the offices and a corner of the general reading room, are the

The Macdonald Engineering Building. View from Southwest.

Prof. P. E. Nobbs, Architect.

stacks. The different functions of the interior are well expressed in the exterior arrangement of this structure, as the long triple windows in the east front of the main reading room and the closely grouped small windows of the stack and offices illustrate.

The decorative details which adorn the exterior are in character with the architectural treatment of the whole. They consist mostly of low relief carvings of vegetable and geometric forms, on the mouldings around the door and window openings, and well sculptured gargoyles at intervals on the cornice.

The interior, reached through a doorway in the tower, has a very nice tone throughout, with the interest chiefly centred on the main reading room. This room is of generous proportions, being 110 feet long, 44 feet wide and 34 feet high, and will easily seat one hundred and fifty readers. The walls are wainscoted in light panelled oak to a height of about eight feet, and an open oak beamed ceiling covers this vast space with pleasing effect. In the east wall there is a group of three long, narrow windows that are filled with good stained glass, in which rich blues predominate. The arrangement of the leading in the other windows shows a carefully studied variety in handling and is well worthy of notice.

The stacks, arranged in four and five stories in the modern seven foot high steel units, have a working capacity of two hundred and fifty thousand volumes, although at present they shelve only about one hundred and thirty thousand books, but the total collection consists of about thirty thousand more pamphlets, maps, and photographs. Of especial interest may be mentioned the Redpath collection of works on English history, and the Griffin library of Canadian history.

Next, in general excellence of design as well as in date, is the Macdonald Physics Building. Mr. Taylor had a much more difficult task here to harmonize the severely technical instruction given within these walls with the picturesque grouping that the style demands, and as is so well exemplified in the Redpath Library. The great laboratories and their adjuncts required for convenience of operation a rectangular building, and the result is an admirably disposed structure on an axis running east and west, with the main front turned towards the south. This building is five stories in height, and is crowned by a well proportioned roof. The ornament is concentrated on the lower and upper stories, in architectural forms, with panels of purely decorative ornament under the windows of the intermediate floors. The architectural ornament on the main floor consists of an elaborate projecting semi-circular porch, which admirably exhibits the characteristics of the Romanesque style. The central portion of the building breaks back above the porch, dividing the facade up into a composition of two end pavilions and a connecting link. This motive of composition is emphasized by a balcony supported on brackets at the level of the upper story, which connects the two pavilions. On the back of the building a similar composition is used, only the connecting balcony is of a different and perhaps more pleasing design.

The interior throughout is simply finished with red brick walls, with plaster or wooden ceilings. The doorways, in many instances, are circular headed and are moulded in terra-cotta with geometric or vegetable patterns, after the Romanesque manner.

There is a finely wrought mantel in the entrance hall with the fitting motto "Prove All Things" cut in its central panel. The delicately carved foliage of the capitals of the supporting shafts and the mouldings of this feature are well worthy of notice, and certainly would excite more attention if the hall were not so small.

The main lecture theatre is up half a flight of stairs from the entrance hall, on the left hand side. It is a fine, high room, finished in light oak and red brick, with a good, heavy flat beamed oak ceiling, and a gallery running across the back and along one side. It will seat at individual chair desks about two hundred persons, and it is fitted with every scientific device for instruction in mathematical physics. The great care exercised to obtain perfect results is shown by the fact that the foundations of the demonstrating desk are carried down to solid rock.

Five years after the completion of the Physics Building and the Redpath Library, the Macdonald Chemistry & Mining Building was opened. This structure is placed between the Physics and Engineering Buildings; thus the group of structures devoted to the use of Applied Science is separated distinctly from the buildings of the other faculties. In style this edifice does not follow the Romanesque form as closely as Mr. Taylor's earlier work, but rather shows a treatment adopted from a later French school, that of the just developed Renaissance, which has more the appearance of being influenced by Spanish, than Italian models.

In this case, as in the one just cited, the structure rises from a rectangular plan to a height of five stories from the main floor, while in the rear, at a considerably lower level, extend shops for the miners and metallurgists to the north and south, making in this way a "T" shaped plan.

Notwithstanding the very ornate entrance motive and the richly moulded cornice at the roof line, this building is

simpler in general treatment than either the Library or Physics Building; the lower story is plainly rusticated and is lighted with arched windows, the intermediate stories are almost severe, with square headed, unornamented openings, while the upper story is somewhat relieved by wall arcades framing the windows. Above the cornice some nicely proportioned ornamental dormers break the sky-line, standing out as they do from a rather low roof. The treatment of the southern face differs from the other sides in that it is divided vertically into a series of bays by buttresses, which terminate under the cornice in inverted scrolls.

The interior contains a lecture theatre, seating about two hundred and fifty students, and several large chemical, assaying, ore dressing and other laboratories. These are all treated more from the utilitarian view point than from one of architectural pretension.

Besides the three buildings already described, Mr. Taylor was the architect of the old Macdonald Engineering Building, which was completely destroyed by fire on April 5th, 1907, the Thomas Workman Mechanical Engineering Building, and the old Strathcona Medical Building, which was partly destroyed by fire on April 16th, 1907.

The remaining buildings of this group show a complete change of style from his other work, being severely plain in their treatment, depending upon an exceedingly well proportioned fenistration rather than decorated mouldings and panels for their chief effect. Looking casually at the old Medical Building, this effect is somewhat lost owing to the wretched colored yellow paint that has been used on the mullions, transom bars and window frames.

After the fire of 1907 two stories were added to the Workman Building. These are easily distinguished from the older work, because they are in dressed stone, which forms a pleasing contrast with the rougher stone work below. More will be said about this later.

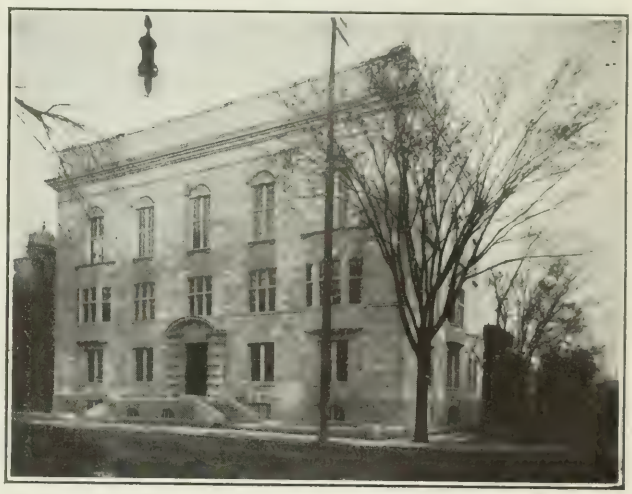
The third group, comprising those structures built in the style of the Early English Renaissance, includes such buildings as the Royal Victoria College, the new Macdonald Engineering Building, the McGill Union and the new Medical Building. These are unquestionably the finest of the McGill edifices, and they show what systematized study has done for the development of modern architecture; built under diverse conditions by men who received their training either in the Old Country or in the larger centres of the eastern States, they show a remarkable homogeneity in style and fitness to their surroundings.

The oldest of these, the Royal Victoria College, the academical and residential hall for McGill's women students, was made possible through the generosity of Lord Strathcona and Mount Royal. This building, opened in September, 1899, was erected from the designs of the late Mr. Bruce Price, formerly a well known architect of New York. Mr. Price is familiar to all Canadians because of his very excellent work in designing the Place Viger Hotel and Terminal Montreal and the still finer Chateau Frontenac at Quebec.

This structure, situated on Sherbrooke Street at the head Union Avenue, just east of the main college campus, has commanding situation that shows the fine design off to the best advantage. The composition consists of two end pavilons joined by a connecting link, which is subordinated the pavilions only by the fine seven-bayed arcade, which rves at the same time as a porch and the joining link. The uilding rises to a height of four stories and an attic, above low basement, and is approached by a broad ramp of stairs qual in width to the three central bays of the arcade. In e centre of this ramp there is a fine pedestal with bronze rnamentations, which is surmounted by a graceful and well esigned seated bronze statue of Queen Victoria.

Each of the end pavilions terminates in a gable, which marks the height of the ridge of the roof of the main building, the eaves line of which is broken up by one major and two minor gables, of similar proportions but smaller than those of the pavilions. Oriel windows, extending through two stories in the pavilions and one story in the body of the building (the connecting link) form the chief decorative note outside of the arcade, on this facade, which depends upon subtile proportions rather than ornamentation for its chief effect. The roof is broken up in an interesting manner by a series of small dormer windows and chimney stacks.

The treatment of the interior is very simple, but the deposition of parts is convenient and good. On the entrance floor there are the offices of administration, lecture rooms, students' common room and a spacious dining room in a separate wing projecting to the north; on the floor above there are more lecture rooms, a library and reading room and the largest assembly hall in the University, in the wing over the dining room; while the two upper floors are devoted entirely to suites of rooms for the resident students and tutors. A well equipped gymnasium service and kitchens



The McGill Union, Sherbrooke Street Front.
Prof. P. E. Nobbs, Architect.

are on the basement. The whole building is well but not luxuriously furnished, and has a comfortable, homelike appearance that is alike beneficial for the student and the visitor.

The new Macdonald Engineering Building, built to replace the former structure which was destroyed by fire in 1907, rises from the old foundations. This handicapped the architect, Professor Percy E. Nobbs of the Architectural Department, now practising under the firm name of Nobbs & Hyde, architects, at the very outset of his task, and made the final solution all the more creditable to him. The main lines of the composition follow those of the Royal Victoria College, that is, the building is composed of two end pavilions and a connecting link, but at this point the comparison must stop, as every line and window of the Engineering Building reflects the serious character of the work carried on within it. This structure rises from a high rusticated base, above which there are four stories in the pavilions and three in the connecting link. The roof is moderately high and is broken up by small dormer windows and some large chimneys at the ridge.

The entrance motive consists of a projecting vestibule, the chief features of which are the flanking rusticated pilasters and a broken curved pediment, above which rises a simple carved group symbolizing engineering. In direct elevation this entrance feature harmonizes very well with the

composition, but from the side the effect is somewhat spoiled by a too great projection. Nicely curved steps lead up to the doorway from either side.

This central decorative note is repeated on the next story in two sculptured panels bearing the arms of McGill, and on the story above by a small balcony carried on fine brackets decorated in low relief carving. At the third story level a second balcony runs across the facade connecting the pavil-

McGill Union, Students' Lounge on Second Floor.
Prof. P. E. Nobbs, Architect

ions; this is interrupted in the centre by an edicule framing a small window and a niche, which runs up and breaks the line of the main cornice.

The ends and the back repeat the treatment of the main front, as far as it is possible to do so, and at the same time join on to the Workman Mechanical Building.

The two upper stories of the Workman Building—the lower one consisting of a high arched motive surmounted by a story with small rectangular openings—is also the work of Professor Nobbs, with its most charming feature to be seen in the far projecting concrete cornice.

The Engineering Building was erected as the permanent home of the Department of Civil Engineering, Architecture and Transportation, but until other structures can be erected the Departments of Electrical and Mechanical Engineering are given here temporary accommodation. The space is allotted as follows:—The great laboratories for the Civil, Electrical and Mechanical Engineers are in the basement and have a clear height of twenty-three feet, which gives ample room for the most interesting experiments. The first floor is devoted chiefly to the Agricultural Museum, the Museum of the Railroad Department, the Engineering Reference Library, and locker space. On the floor above are the architectural draughting and lecture rooms and reference library, the private offices of the professors and the faculty room; while the two upper floors are given over to large draughting rooms and lecture halls.

No special interior architectural effect has been sought after in this building, the dominant note being security against fire, as each of the floors is divided into sections by unplastered brick fire walls, with great copper fire doors operating automatically with a fusible link to isolate any conflagration that might start.

The halls, lecture and draughting rooms and museums are finished in a lovely rich buff yellow brick, laid up in various bonds. In some cases the brickwork is four-foot wainscot only, in others it goes up to the ceiling; when the wainscot is used, the walls above are plastered and tinted an agreeable shade in a low key. The central portion of the second floor, used for administrative purposes, is more decorative than the rest of the rooms: here the corridor is wainscoted with mat glazed white terra cotta tiles, with at intervals decorative panels in terra cotta, symbolical of the different departmental activities. In the faculty room there is a fine but simple moulded ceiling, with a great elliptical panel in the centre, framed with a rich band of fruits and flowers in low relief. The walls are tinted a delicate green, and the hangings are a dull orange buff. The finish of the furniture blends in color with the hangings, giving to the whole room a warm and attractive aspect.

The furniture throughout the building was also designed by Professor Nobbs; it is particularly interesting on account of its variety, the excellence of the substantial designs, the fine workmanship and beauty of finish.

The most beautiful of Professor Nobbs' buildings is the McGill Union, situated just off the college campus on the corner of Sherbrooke and Victoria Streets. It is a rectangular structure 91 feet long by 71 feet deep, and rises in three well proportioned stories above a low basement. The upper story is terminated by a nicely moulded cornice, which is crowned with a high plain attic. The chief decorative features of the main front are the entrance and two oriel windows on the second story at either end of the composition. The doorway consists of a pleasing shallow porch, formed by a group of three rusticated pilasters, crowned by a curved pediment, in the tympanum of which there is a shield bearing the arms of McGill. In the centre of the Victoria Street elevation there is, also on the second story level, an oriel window which is flanked by two slightly projecting decorative chimneys which break through the cornice in a pleasing manner. The windows of the upper story are considerably higher than those of the stories below, and thus fittingly express on the exterior the great hall within.

New Medical Building. Front Elevation from Upper Campus.
Brown & Vallance, Architects.

The arrangement of the interior, which is given over entirely to social intercourse between the students of all faculties, is very simple, but well laid out; it is further a splendid expression of the proper handling of different colored materials to obtain a rich and harmonious effect. On the entrance floor, beside a commodious hall, there are the dining and grille rooms; on the second floor there is a splendid lounging gallery, running across the whole front of the building, 88 feet long by 21 feet wide, back of which are billiard, news and reading rooms, a library and a study. The top floor is given over to the great hall in front—a room 88 feet long by 45 feet wide—and several small rooms for society meetings. The interior is too rich and varied to be properly described within these limits, but particular attention must

be called to the delicate moulded plaster work of the ceilings and cornices, the grace and variety of the wrought iron details, the interesting heraldic devices, the fine joining of the panelling and furniture, and the varied and harmonious color scheme of the whole.

The last of the English Renaissance group forms the latest addition to McGill's equipment. This is the New Medical Building which was completed only last spring from the designs of Messrs. Brown & Vallance, architects, Montreal. This structure is without question the finest building of the University and one of the finest in the whole Dominion, the great pity being that its situation at the corner of University Street and Pine Avenue, although excellent on account of its proximity to the Royal Victoria Hospital, is unfortunate from the view point of the observer, as besides being somewhat screened, the sharp rise in the ground from the Milton Street level to the building makes it very difficult to see more than a portion of the composition at any one time.

New Medical Building. Rear Elevation from Royal Victoria Hospital, Showing North Wings.
Brown & Vallance, Architects.

In plan this building is of the conventional "E" type with the three wings projecting to the north. The body of the building to the south recalls the northern divisions in the main masses, and joins them by recessed stair towers, which are built out from the lower story, to form the entrances. The central portion is given over to the library and stack, the reading room being on the top floor, while the other two floors above the basement are devoted to the storage of books and supplies, and for administrative purposes. The east and west wings, to the south, are occupied by smaller departmental laboratories and lecture rooms; while large laboratories, the museum and an assembly hall fill the northern wings.

The interior disposition is exceedingly well expressed in the arrangement of the outside, the library, for instance, with its three oriel windows; the stack below by slit openings, while the great laboratories and halls are shown by large finely proportioned windows.

The interior is treated with the same simple harmony that characterizes the exterior, and is so designed that the first impression is one of spaciousness and light. The halls, corridors and many of the rooms are finished with a mat white terra cotta wainscot, the dead whiteness of which is relieved by shields bearing the names of famous men of medicine in red or gold letters, or colored heraldic devices.

The Museum, three stories in height, occupies the central northern wing. It is a cross in plan, with a low glass dome over the central rotunda. The faculty room on the ground floor with its fine mantel, and the reading room on the top floor, show the refinement and simplicity to which this style lends itself.

Of the other buildings Strathcona Hall, the home of the University Young Men's Christian Association, on Sherbroke Street, just opposite the college gate, and the new power station, back of the Arts Building, are the most interesting. Strathcona Hall was built from the designs of Messrs. Finley & Spence, architects, of Montreal. It is a rectangular building of the modified French type, five stories in height. The two lower floors are given over to social purposes, while the upper ones afford residential accommodation for about sixty students. The interior is nicely finished, but is not as rich or varied as the interior of the Union.

The Power Station, the work of Professors Nobbs and Durley, has a splendid equipment, which includes boilers of 1,000 h.p. and engines and generators of 600 kilowatt capacity. The heating distribution is partly by tunnel and partly by underground conduit, and is utilized in the New and Old Medical, Engineering and Workman, Chemistry & Mining, and Physics Buildings. The electric current for light and power is distributed through cables in vitrified clay conduits to all of the above structures as well as to the Royal Victoria College, the Union and Strathcona Hall.

In conclusion, the general impression left on the mind by the McGill group is one of homogeneity and repose. The diverse styles of the individual units is lost in the spaciousness of the campus, which at the same time separates yet binds the buildings together. Out of this whole, two buildings stand forth prominently, Molson Hall and the New Medical Building, the older one dominating the lower campus, the newer one the upper campus. Two other buildings also claim attention, the Union and the Royal Victoria College, but on account of their isolation they lose in comparison with the main group.

A NOVEL METHOD OF POURING CONCRETE BRIDGE FLOORS.

In the construction of the main viaduct of the McAdoo Tunnel extension into Newark, a very interesting method was used in pouring concrete bridge floors, which are trough-shaped and each 13 ft. wide, 11½ in. thick, and laid in sections 250 ft. long with expansion joints between.

The forms are built complete several hundred feet in advance of the concrete, and the reinforcing steel is set and tied by the force of the steel contractor before a run of concrete is started. Concrete is then placed by two traveling plants on the deck of the viaduct. One consists of a 7-ft gauge car carrying a 1-yd. Ransome mixer and timber feeding bins.

It runs on the temporary track mentioned at one side of the slab which is being placed. This track has three rails to accommodate standard-gauge and the 7-ft. gauge. A locomotive crane on the track accompanies the traveling plant and supplies its bins from material cars standing on one side of the outer freight tracks below. Concrete is delivered from the mixer to any part of the slab on the opposite half of the viaduct by a sectional chute, and is tamped in place by the concrete gang. Under this plan of operation 250 ft. of single track slab is placed in an 8-hour day and at times two sections, or 500 ft., have been laid, the time required being 14 hours. On a part of the work, in placing the second track-slab, a second mixing plant has been installed, consisting of a mixer on a flat car, with the material cars coupled at the ends. This traveling plant moves over the completed first track and operates similarly to the other described.

THE GREAT NATIONAL PORT OF CANADA.

Features of the Important Extension Works in Progress in Montreal Harbor.

By FREDERICK W. COWIE, Chief Engineer for the Montreal Harbor Commissioners.

The first attempt to make a harbor for ocean vessels at Montreal was in 1830.

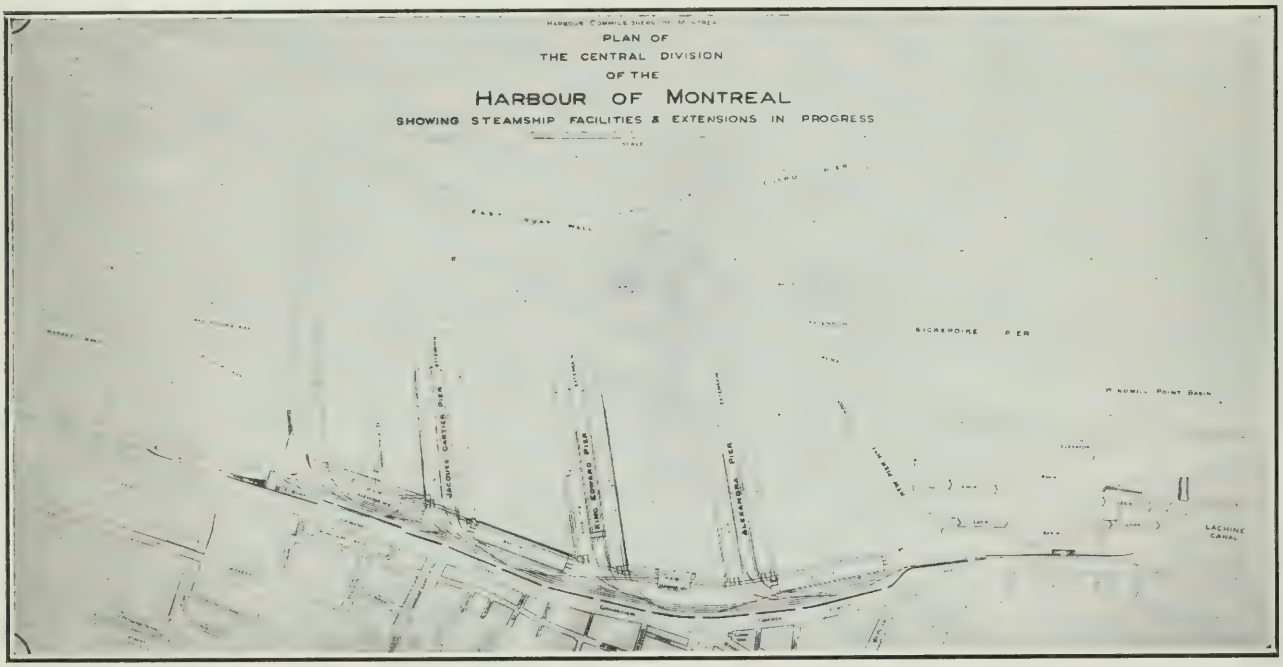
The Canadian inland canal system, connecting the Great Lakes of the central part of the North American continent with the St. Lawrence at Montreal, had just been opened. The physical features of the locality, the trade situation, and the position as a point of interchange between ocean and inland vessels was recognized.

The city of Montreal was fast becoming a commercial and manufacturing centre, and the situation for warehouses and trade was excellent.

From 10 feet in 1850, the channel had been deepened in 1888 to 27½ feet at ordinary low water, over a length of river requiring dredging of about 50 miles, the work being carried on departmentally by the Harbor Commissioners of Montreal.

In 1888 the Government of Canada, recognizing the St. Lawrence as the national route of Canada, assumed the debt incurred with respect to the channel and opened the waterway free to the shipping of the world.

The government, in 1899, undertook the task of deepening the channel about four feet to obtain a depth of 30 feet



Plan of Central Division, Montreal Harbor.

Eastward was the mighty St. Lawrence, with its clean water and permanent river bed, passing through Lake St. Peter and on 160 miles to Quebec, and 800 miles farther to the Atlantic Ocean.

Navigation to Quebec was an accomplished fact for all classes of ocean vessels, but at Lake St. Peter, half way up to Montreal, there was only a depth of 10 feet at low water.

The River St. Lawrence Ship Channel.—Commencing modestly, as it would be considered at the present time, but on right lines, the Montreal far-seeing business men undertook to construct a harbor and to deepen the channel through Lake St. Peter.

Their lessons were gained from the successes in taking navigation up the Clyde, which, before being improved, had been a shallow stream, but with the deepening of the river had resulted in creating the port of Glasgow.

Dredging on the St. Lawrence commenced in 1850. The plant was designed and the machinery made in Scotland.

of the lowest stage of river level recorded, and of widening, straightening and marking the channel with the most modern system of aids to navigation.

In 1907 the channel was opened to commerce with a depth of 30 feet, the actual lowest recorded depth that season being 31 feet 10 inches, and having a magnificent system of lights, buoys, signal service and swept channel.

The standard curves are easy and the width ample, as compared with any other artificial navigable waterway of the world.

Montreal harbor and the St. Lawrence has had a bad name. It is unfortunate that in Canada misfortunes are often unduly advertised. The facts and actual records show to the contrary, and the St. Lawrence should be known as the most advantageous route in the world.

The St. Lawrence, as well as the whole of the Great Lakes navigation, amounting to 70,000,000 tons per annum, is closed by ice from December to April of each year. This situation is accepted for the present, but the future may

bring about great changes, both on the Lakes and the St. Lawrence.

During the navigation season the St. Lawrence has splendid weather conditions, and is notably adapted to navigation. Fogs are very rare in the whole of the contracted part of the river between Murray Bay, 235 miles below Montreal, right up to the harbor.

In 30 years only two ships have been totally lost between Quebec and Montreal.

Groundings, which are so well advertised, are not frequent. The reports of 1906 state that between Montreal and Quebec the loss due to navigation accidents did not amount to $1,000. During the season just closed only one marine accident of any importance happened in the ship channel, when a large freight ship grounded a short distance below Montreal and was released by tugs after lightering part of the cargo. None of the accidents whatever in recent years have been due in any measure to the channel.

Montreal Harbor.—In the consideration of Montreal as a position for a great port, except for its winter season, it would be regarded as an ideal situation, according to the best British and Continental practice.

1. It is as far inland as it is possible for ocean navigation to go.

2. It has a splendid channel approach and dredging plant organization at least equal to any in the world.

3. The navigable conditions are excellent.

4. It is on the direct lines of the great summer trade route of North America.

5. It is the nearest and most advantageous ocean port for a large section of the North American Continent's most productive area.

6. It is a route which, with its up to the present meagre facilities, has successfully held its own with the Buffalo-New York route.

7. It is the eastern terminus of the St. Lawrence Canal System, giving 14 feet navigation, from Montreal to Port Colborne.

From Port Colborne the depth is 20 feet to Buffalo, Cleveland, Detroit, Chicago, Sault Ste. Marie, Fort William and Duluth, a total distance of 1,400 miles.

8. Montreal is the railway centre of Canada, trunk lines extend in every direction and three transcontinental lines first reach ocean navigation at Montreal.

9. Physically, Montreal is favorable for the construction of a port.

10. The water is free from sediment and constant dredging is not required.

11. The whole of the water front and river bed is controlled by the port authorities.

12. The harbor is in the heart of the business section of the city.

13. The railway connections with the docks are the best on the continent.

14. The great transportation companies of Canada, both rail and water, have their headquarters in Montreal.

15. The trade by the St. Lawrence to and from Montreal is now 25 per cent. of the total foreign commerce of Canada.

The total length of wharfage is 38,097 feet, or 7.215 miles.

The total shed area is 35 acres.

There are no tonnage dues on vessels.

The revenues are chiefly derived from wharfage rates on the goods, rentals of sheds and space, storage and handling of grain and operation of harbor railway terminals.

Payment of pilotage to the port is compulsory, and it is controlled by the Government of Canada.

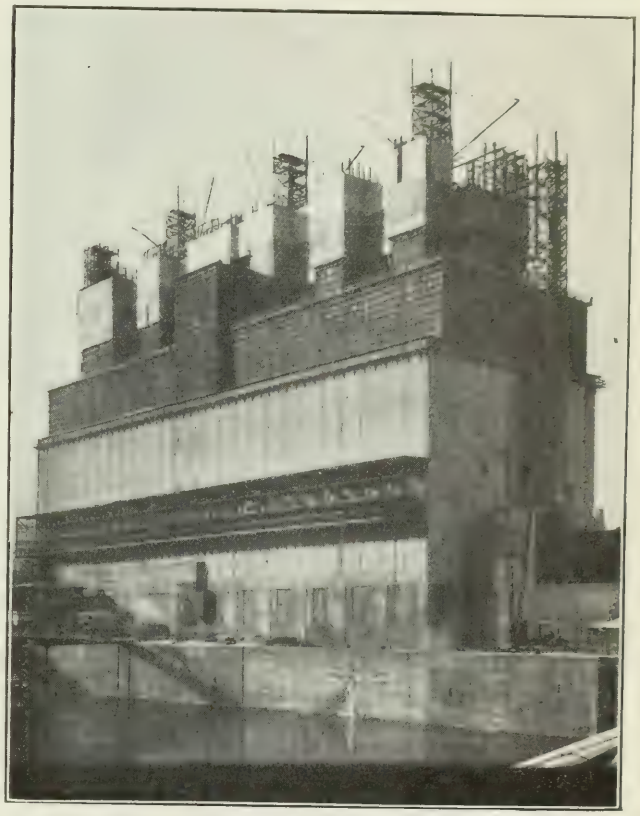
Physical Description of Montreal Harbor.—The jurisdiction of the harbor commissioners extends over the whole of the River St. Lawrence, with the exception of the ship channel, from Bout de l'Ile to above Victoria Bridge, a distance of 17 miles. This area comprises all the land under water and the beaches up to high water mark, including the whole of Ile Ronde. Thus the whole of the water front on both sides of the river is under the jurisdiction of the commissioners, who hold it in trust and administer it for the Government of Canada.

The total water area is 12,000 acres.

The total land area, improved, is 200 acres.

The present harbor represents a development of 80 years.

There is no rise and fall of tide, but the river level fluctuates to an extent of about 12 feet from high water in the spring to low water in the autumn. During the winter, due to ice shoves, the water occasionally rises to an extreme of 28 feet above the low water level.



Elevator No. 2 Under Construction for Harbor Commissioners of Montreal.

An artificial embankment, parallel to the shore, about one and one-third miles long, protects the whole of the upper part of the harbor, including the entrance to the Lachine canal, from not only the currents of the river, but from ice shoves. This constitutes the protected tidal basin in which the water rises and falls with the river level.

It has not been necessary to purchase any land above the high water mark on the beach, as all piers and wharves have been made artificially by building out into the shallow water, and the berths formed by dredging.

The Storage and Handling of Grain.—Montreal harbor being the farthest inland ocean port on the Northern Continent, and also the terminus of the inland Canadian canal

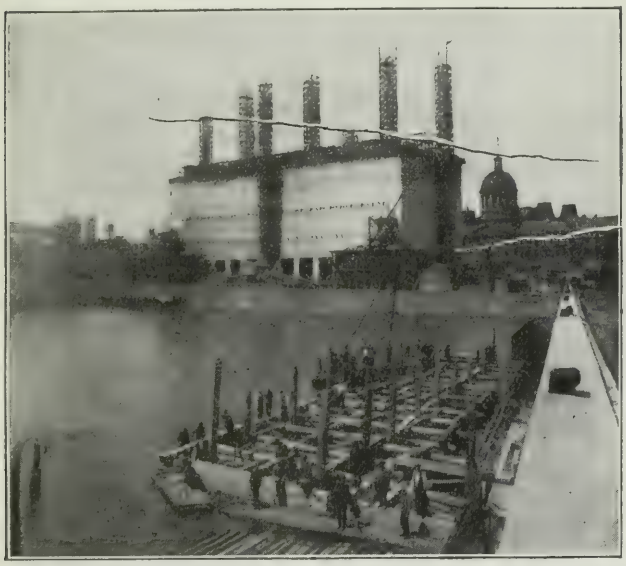
and railway routes, it is an important factor in the grain-carrying trade of the northern part of the continent.

A few years ago the bulk of Western grain came to Montreal in barges. These vessels, without machinery and with small crews, could afford to hold grain in storage until the ocean ship was ready for it, and the grain was then transferred from the barges to the ships by floating elevators.

With the enlargement of the canals, much of the grain now comes to Montreal in steamers capable of carrying about 2,500 tons on the present 14-ft. draft of the Welland and St. Lawrence canals. These vessels cannot afford to wait, but must unload their cargo at once, otherwise they will not choose this port.

Grain coming from Georgian Bay ports by rail must also be unloaded quickly, as even now, during the grain rush, there is a constant railway car shortage.

In the last few years, therefore, the storage and handling of grain has become a new problem in harbor economy. In order to solve it, the harbor commissioners in 1903 erected a modern storage elevator, having a capacity of 1,000,000



Victoria Pier, Showing Construction of Cribwork Substructure New Finished Concrete Quay Wall.

bushels. The G.T.R. leased a site from the harbor commissioners and also erected an elevator, in 1904, having a capacity of 1,000,000 bushels. Other elevators having a capacity of 2,100,000 bushels have been principally occupied with local business.

Elevator No. 2.—Additional storage capacity being urgently required, the construction of Elevator No. 2 was commenced in 1910. The site chosen was on the bulkhead wharf, opposite Jacques Cartier Square, between Jacques Cartier and Victoria Piers. Although planned in 1909 to have a capacity of 1,000,000 bushels, the designs were made in 1910, by order of the commissioners, for a capacity of 1,750,000 bushels, and the elevator was commenced. The grain congestion in 1911, being even more acute than in 1910, the commissioners decided in July, 1911, to enlarge the storage capacity of the elevator under construction to the total of 2,600,000 bushels.

The unique feature with regard to the handling of grain in Montreal harbor is the placing of the elevators in such positions that by a system of conveyors the grain can be carried direct to the ships at their different berths and delivered without interfering with their ordinary loading and unloading.

The construction of the marine tower jetty, the new quay wall in front of the elevator, the excavation for the site and the railway tracks were undertaken directly by the harbor commissioners' engineering department.

The elevator designs and construction were given to the John S. Metcalf Co., Ltd., as designing and constructing engineers for the commissioners.

The illustration showing Elevator No. 2 gives an idea of this immense structure and its progress towards completion.

It is not claimed to be the largest elevator in the world, but it will be the most completely equipped and connected with the most extensive conveyor system ever put into operation.

The elevator, while designed primarily for car business, will have two unloading berths for vessels and, with a receiving capacity of 250 cars of grain per 10 hours with an equal quantity by vessel, it should take a foremost place in the Canadian equipment for the storage and handling of grain.

The new elevator is built of reinforced concrete throughout. It is a structure 456 ft. long by 100 ft wide. The receiving elevator is 314 ft. long by 100 ft. wide. The bins have been completed and the frame work of the cupola has been carried up almost to the top. The portion of the elevator, 142 ft. long by 100 ft. wide, which will be used for storage purposes only, has not yet risen above the surface of the ground; the driving of concrete piles for this portion being now in progress.

The working elevator is built on wooden piles cut off at low water level, which is about 25 ft. below the top of the wharf. In order to get the elevator pits to the necessary depth, a deep basement is required and for that reason the excavation is carried down to low water mark and wooden piles driven. For the storage addition, where no basement is required, concrete piles with their tops 17 ft. above low water level are used.

The wooden piles beneath the working elevator are covered with reinforced concrete slab 3 ft. thick. On top of this the piers and walls of the foundation are built up to approximately track level. The first story consists of large reinforced columns and girders supporting bins. The bin walls are of reinforced concrete 90 ft. high with walls 8 in. thick. Total number of bins in the building is 205. The bin bottoms are of reinforced concrete of a design originated especially for this elevator, which affords a large amount of head room in the first story. On top of the bins the cupola is built. This consists of reinforced concrete column and girder work, with floors, roofs and curtain walls of concrete. The top of the bins is 113 ft. above track level, and the cupola is 107 ft. high above the top of the bins, making the total height of the building 220 ft. This elevator is, therefore, one of the very highest reinforced concrete buildings ever constructed in any country, about as high as a 16-story office building.

In the construction of the bin walls of the elevator moving forms were used. They were raised by means of 1¼ in. threaded steel rods imbedded in the concrete, on which a special nut carriage is used. This nut carriage is turned by means of steel bars and as it climbed the rods the forms moved upward with it. The bins were constructed in two units. Progress on the first unit being at the rate of about 4½ ft. per day, and on the second unit of over 6 ft. per day.

The new elevator marine towers and galleries will be operated by electric motors, as are the present elevator and galleries. The new motor equipment will total about 5,500 horse-power, and a very efficient and complete system of telephones and electric signals between the shipping gallery and

elevator and between various parts of the elevator will be installed.

High Level Railway Tracks.—The railway tracks on the wharves were formerly all located on what is commonly termed low level wharves. This level is above the level of floods during navigation season, but during the winter and spring floods is always submerged. In 1898 the wharves in the central part of the harbor were raised to high level, that is, 24 feet above the low water. These high level wharves have only been submerged on two or three occasions during record spring floods.

The high level wharves, up to the year 1910, were only included in the central part of the harbor, and between Victoria Pier and the eastern limit of the harbor railways that were constructed at low level and, therefore, not only put out of business in winter, but required a great deal of work for repairs and removal of ice in spring in order to prepare them for traffic.

In 1910 the harbor commissioners authorized the construction of high level railways from Victoria Pier eastward, for the purpose of facilitating traffic all year round and for the abolition of level railway crossings.

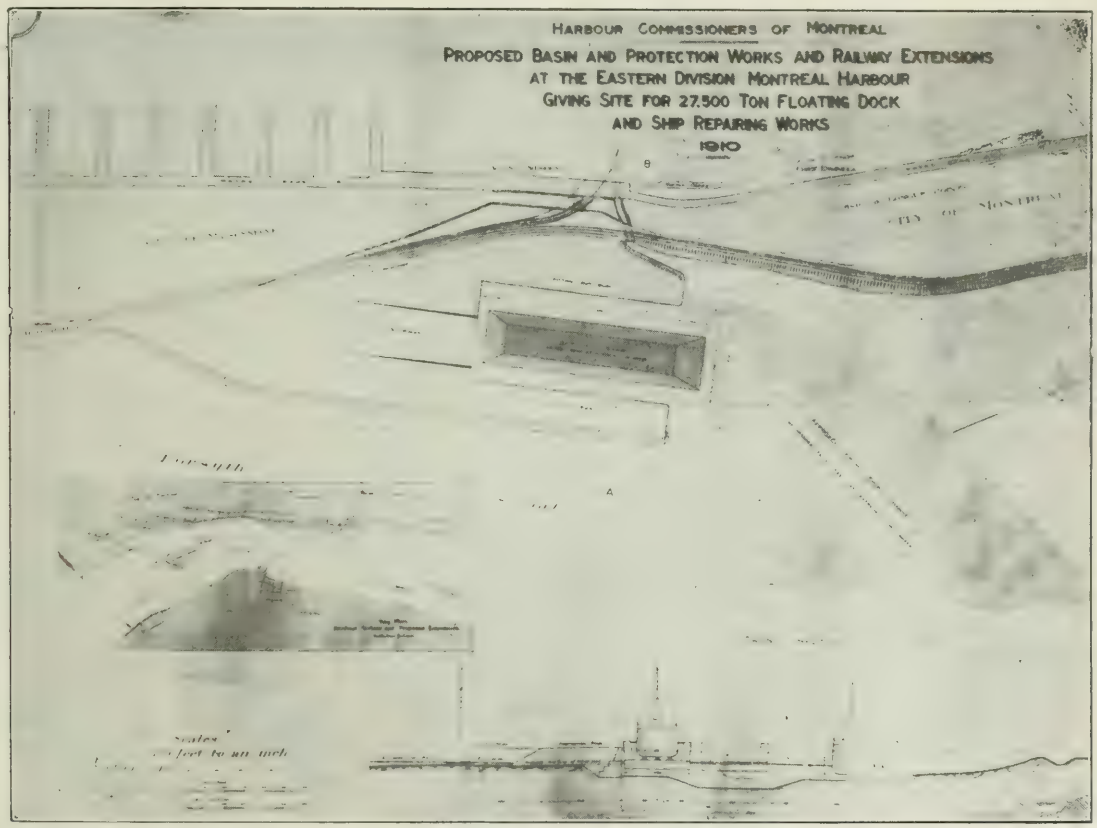
The method of raising the level consisted in the construction of an earthwork embankment, the track being elevated to an extent of about 14 ft. to a level which would be above extreme spring floods.

At 11 of the most important connections with city streets subways were constructed with permanent concrete abutments and steel bridges. At the two important city approaches, opposite Bonsecours market and Berri Street, opposite the subways leading to the harbor, switching railways on the low level were completely abolished and the wharves permanently paved. This now permits the large number of passengers and carriages appoaching to or coming from river steamers to pass without danger from the greatly increased railway traffic along that important railway thoroughfare. At the Longueuil Ferry, another important passenger landing, the low level railway track was also removed and another safe and convenient access between the ferry steamers and the city streets provided.

The construction of this high level railway embankment was commenced in 1910, and was fully completed during the past season. In the construction of this embankment about 650,000 cubic yards of material were used.

Twelve miles of new railway track were laid, eleven steel bridges were constructed, and 520 tons of rock ballast were used.

The harbor railways, which are operated directly by the harbor commissioners' traffic department, now extend from the foot of the Lachine Canal eastward to Racine Pier, along a water front of 5½ miles. Railway connections are given to the G.T.R., the C.P.R., the C.N.R., and the Montreal Locomotive Works.


HARBOUR COMMISSIONERS OF MONTREAL
PROPOSED BASIN AND PROTECTION WORKS AND RAILWAY EXTENSIONS
AT THE EASTERN DIVISION MONTREAL HARBOUR
GIVING SITE FOR 27,500 TON FLOATING DOCK
AND SHIP REPAIRING WORKS
1910

General Plan, Dry Dock Site.

Victoria Pier and Market Basin.—In the scheme of extensions, designed in 1909, every consideration was given to enlarging the steamship accommodation in the central part of the harbor, to connect with the present shed system and the successful grain equipment already in operation and proposed for this season.

At the same time, it was recognized that river and passenger and market vessels should have a location convenient to the city transportation systems and the Bonsecours market.

The improvement of the old Victoria Pier was proposed on the same lines as the old pier, except that the upper and outside quays should be high level for steamships, and the whole of the inner basin quays low level, fitted with slips and exclusively devoted to vessels of the river class.

As most urgent, this was one of the first items of work commenced in 1910. It involves construction in the most congested part of the harbor, while passenger and general market and shipping business is being carried on.

The high level steamship portion will give berths for five ocean vessels, where permanent sheds, railway and grain shipping facilities will be available. The completion of it will involve the widening of the ship channel to 700 feet, the diversion of the guard pier to give the necessary room and protection and compensation by enlarging the channel for the outlet of a portion of the flow of the river, south of St. Helen's Island.

Construction Work, Dry Dock Basin.

The present three piers, which are too short, may then be lengthened according to the plan of extensions.

The market basin, designed for river vessels, will provide 4,000 feet of quays, or 20 berths, averaging 200 feet each. This wharf is all to be constructed at low level, with slips in the concrete quay walls for the convenience of this class of vessels, most of which load and discharge by gangways.

At the close of the season of 1911, 600 ft. of high level quay wall had been completed, and 300 feet advanced sufficiently so as to be capable of completion in May, 1912.

The contract was let for the construction of the first permanent transit shed, which was designed to be similar to the 14 two-story fireproof sheds already erected. By the close of the present year foundations will have been completed for this shed and erection of the steel work commenced, and it is hoped that this first permanent berth in connection with the present scheme of extensions may be sufficiently advanced to be occupied early next season.

The special engineering features in connection with this large work of construction are the wooden cribwork founded 37 feet below low water level, and strong enough to carry a solid concrete wall 24 feet high from low water level to cope; the filling of the interior of the wharves and the putting in of a system of reinforced concrete piling through the newly filled ground to hard bottom, for permanent sheds; and the means taken to make the concrete walls, when constructed in water, able to withstand the disintegrating action of weather and frost.

Dry Dock Site.—One of the most important items of construction work in connection with the progress of the harbor improvements is the important work of providing a site for a floating dock in the eastern division, below St. Mary's Current.

A glance at the chart will show, at the boundary line between the town of Maisonneuve and the parish of Longue Pointe, near the outlet of Molson's Creek, a natural bay. This bay, where the water is very shallow, and which is of large extent, appears to have been admirably adapted by nature for the purpose of a dry dock or shipyard. There is ample room between the ship channel and the shore. No streets or railways intersect the site. The river is wide and the current very gentle.

The site is connected with the harbor commissioners' independent railway tracks, which themselves connect with all Montreal railways. The important main lines of the street railway service pass close to the site. The new and extensive works of the Montreal Steel Works or Canadian Steel Foundries, Ltd., which will be one of the most up-to-date steel plants on the continent, are rapidly nearing completion, just across Notre Dame Street, the extensive Locomotive Works, Structural Steel Works, National Bridge Co., and the Canada Cement Co., besides a host of other manufacturing industries attracted to this locality, are branching out and flourishing in this immediate neighborhood.

Considering, therefore, labor conditions, access by railways and steamships and the physical suitability of the site, the construction of the Dry Dock Works is meeting with unanimous approval.

The harbor commissioners are supplying the protected basin, wharves and deep water, as well as an area of 30 acres of made land for shipyard and subsidiary plant.

Messrs. Vickers, Ltd., the celebrated shipbuilding firm, of England, through the newly-organized firm of Canadian Vickers, Ltd., under contract with the government and the harbor commissioners, are to construct and maintain the floating dock and a magnificent shipyard and repair plant.

"Sir Hugh Allen" Towing Dredge from Quebec to Montreal.

The unusual features in connection with this construction job are the deep dredging; the tremendous amount of filling in, disposing of the dredged materials so as to make valuable land for the ship yard, and the construction of 2,500 feet of standard cribwork and concrete quay walls.

General Items of Construction.—Two reinforced concrete one-story transit sheds are under construction on the Tarte

Pier, and are sufficiently advanced to assure their availability early next season.

A new ferry wharf, a locomotive round house and shop, a new 10-ton electric hoist and dredges under construction will, in addition to the larger items of construction, be of interest to civil, electrical and mechanical engineers.

With the exception of buildings and steel hulls, all the harbor commissioners' construction and repair work is carried on departmentally, and plant belonging to the organization consists of a very complete and up-to-date equipment.

The new and powerful tug "Sir Hugh Allen," built for the harbor commissioners in 1911, completely fulfilled the expectations and requirements. Received in July, this tug was immediately put to work towing scows up the St. Mary's Current, towing the floating crane between Montreal and Sorel and Quebec, and handling and towing dredges.

This tug, strengthened for ice work, made a record by sailing from Montreal to Pointe-aux-Trembles on New Year's Day, 1912, the river being still open.

During the season a total of 1,805,340 cubic yards were dredged; a total of 28,934 cubic yards of concrete were constructed by the departmental force of the commissioners; a total of 3,290,470 cubic feet of crib work constructed; a total of 1,229,620 cubic yards placed in the embankments and reclaimed land areas by derricks and 2,562 lin. feet of quay wall constructed.

A maximum number of 1,233 men were engaged, not including work being carried on by contract or the special force engaged on Elevator No. 2.

The important items of material were all purchased by public tender, including 12,300,000 ft. B.M., of timber; 42,000 tons of broken stone; 24,000 tons of unbroken stone; 31,490 cubic yards of sand and gravel; 82,000 barrels of cement; 275 tons of steel and iron castings; 2,000 tons of steel and iron bars; 16,000 tons of steam coal; 700 tons rails and fastenings, and 325 tons of wharf spikes and nails.

The season of navigation for 1911 opened by the arrival of the first trans-Atlantic steamship, the "Royal George," of the Canadian Northern Steamship Co., and navigation is still open, the commissioners having made an inspection of the harbor on January 1st, 1912.

PROGRAMME OF THE TWENTY-SIXTH ANNUAL MEETING, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting for the election of officers and members of council for 1912, and for the transaction of business, will be held as follows in the rooms of the society, 413 Dorchester Street West, Montreal.

Wednesday, January 24th.—10 a.m. Meeting for the nomination of scrutineers, receiving the report of council reception and discussion of reports of committees, and transaction of the general business of the society.

1 p.m. Adjournment for members' luncheon in the Windsor Hotel, Montreal, to which the visiting members are invited by the members resident in Montreal.

3 p.m. Continuation of the business meeting for the discussion of reports, etc.

4 p.m. An address by the retiring president, Mr. C. H. Rust.

8 p.m. Address by Dr. H. T. Barnes on "Iceberg Detection in Navigation," in the lecture hall of the Chemistry Building, McGill University.

9.30 p.m. Reception by the president and members of council in the Engineering Building, McGill University, and inspection of the laboratories and workshops.

Through the courtesy of the Board of Governors of the University, the building has been placed at the disposal of the society for this evening. Members and ladies accompanying them are invited to the reception and lecture. Cards will not be issued.

Thursday, January 25th.—Two parties will be formed for the purpose of visiting engineering works.

(a) The Angus shops. By the courtesy of the Canadian Pacific Railway Company, a special train will convey this party to the works, leaving the Windsor Station at 10 a.m. Dining cars will be attached to the train, and luncheon will be served during the inspection of the works.

(b) The works of the Dominion Bridge Company and the Canadian Car and Foundry Company. By the kindness of the Montreal Street Car Company, cars will be in waiting at the Windsor Hotel, and will leave there at 10.30 a.m. sharp, for Dominion. The Bridge Company will lunch this party at 1.30 p.m., and the works of the Canadian Car Company will be visited on the return journey.

8 p.m. Annual dinner in the Windsor Hotel.

Friday, January 26th.—10 a.m. Meeting for the reception of reports of scrutineers and conclusion of the business of the annual meeting.

3 p.m. Meeting of council.

By the kindness of the railways of the Eastern Canadian Passenger Association, members and their families who have paid a full one way first-class fare going to the meeting in Montreal, will be returned free on presentation of a standard convention certificate signed by the ticket agent from whom a ticket has been procured at the point of commencement of the journey. The certificate is to be endorsed by the secretary of the society, and to be vised by a special agent of the Passenger Association who will be in attendance at the meeting from 3 p.m. to 6 p.m. on Wednesday and Friday, January 24th and 26th. A fee of 25 cents will be charged by the Passenger Association in each case.

The Canadian Pacific Railway and the Canadian Northern Railway will grant a further extension of time to persons residing west of Fort William, making this free return available for 15 days after the close of the meeting; the ticket to Montreal having been purchased at any time and receipt obtained therefor on the standard convention form as above.

Tickets to the luncheon may be purchased at the rooms of the society. Prices: Luncheon $1.50 to resident members, dinner $3.00. C. H. McLeod, Secretary.

THE WINDSOR STATION OF THE CANADIAN PACIFIC RAILWAY AT MONTREAL.

When a company has 75,000 employees on its pay rolls it becomes a big problem to keep strict account of their doings, and when, as in the case of the Canadian Pacific Railway, these employees are scattered over practically the whole world, the office space required to properly tabulate information regarding them is enormous. In the earlier days of the C.P.R., when a ten per cent. dividend, as well as the hundred millions earnings per annum were a matter of years, the office problem was of not so serious a nature, but within the last decade the volume of business passing over the company's lines has been so great, and its many side interests have paid so handsomely, that its staff has increased by the thousands, necessitating a corresponding increase in office space. We have had an example of this only recently in Toronto, where the C.P.R. is erecting a sixteen-story building at the corner of King and Yonge Streets.

Another example is afforded in Montreal. In this city alone, there are 12,000 people in the employ of the C.P.R., and while these do not all work under the same roof, it has

been found necessary to build a huge extension to the Windsor Street station, in order to properly look after the work and general conduct of the company's employees.

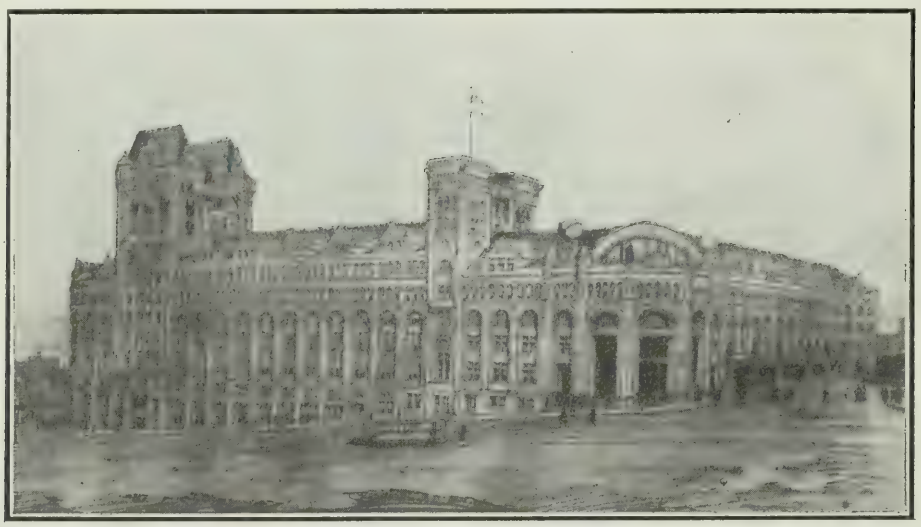
The history of the Windsor Street station is practically the history of the C.P.R. itself. The first and original Windsor station, erected in 1889, was only a small affair, but as the company's business grew it was added to until this, the fifth extension, will make it the largest and most complete railway station in Canada.

The present building is situated on the southwest corner of Windsor and Osborne Streets, and the extension is being built just south of this, so that the new station extends from Osborne Street on the north to St. Antoine on the south, and from Windsor on the east to Mountain Street on the west. The extension proper has a frontage on Windsor Street of 293 feet, and on Osborne of 850 feet, so that taking into consideration the offices now occupied by the Dominion Express Company on Osborne Street, the station, as it will be when the extension is completed, will have the following frontages: on Windsor Street, 493 feet; on St. Antoine, 175 feet; on Osborne, 850 feet. This gives the station a ground floor area of 77,000 square feet.

crete work has also been completed, including the building of a huge viaduct for the carrying of the tracks. This viaduct was rendered necessary by the Windsor Street grade, the tracks having to be brought in at a height of about forty feet above St. Antoine Street, in order to have them on a level with those now in use. The foundations of the building are the heaviest ever built in Montreal, the concrete piers going down forty feet to solid rock.

Plans for the whole interior of the building have not as yet been completed, but in this connection considerable remodeling will be done in the present structure. At present the main entrance is on Osborne Street, but this will be moved directly to the Windsor Street corner, and there will also be main entrances at the foot of the tower and at the St. Antoine Street corner. The offices now used by the ticket sellers will be moved to another part of the building, and they will be greatly enlarged, and other sweeping changes will be made.

Entering from the St. Antoine Street corner the main floor can be gained either by two huge passenger elevators, or by the marble stairways on either side of the doorway. These will admit of a direct entrance to the concourse, which



Windsor Station, Montreal.

In point of height the new building is the highest in the British Empire. When the new C.P.R. offices in Toronto are erected it may possibly have a rival in this respect, but until that building materializes, Montreal has the highest building. This is Montreal's first sky-scraper. They have several of the ten-story variety, but this one is sixteen stories. In reality it has three heights. Starting at Osborne Street, Windsor Street slopes down to St. Antoine at an angle of about twelve degrees, and the building has been planned to conform with this slope, the present height of 60 feet at the corner of Windsor and Osborne. being retained, while at Windsor and St. Antoine the height is 105 feet. About half way between Osborne and St. Antoine is the tower, and here is where the greatest height is, the building towering up 214 feet from the pavement to the base of the flag pole. For sight-seers this will prove a splendid site for a panoramic view of Montreal, and long stretches of the St. Lawrence river will be visible from its upper stories.

Before work on the extension could be started, the land had to be cleared. This was a work of some dimensions in itself, as there were a number of large brick buildings on the property. Good progress was made with the work, however, and now the extension of the building is practically completed. The con-

will include the present concourse, giving it a total floor area of about 8,000 square feet. It will be 26 feet high, and will be beautifully finished. On one side of the general waiting room will be a long row of ticket offices, and from here, too, access to the ladies' waiting room will be gained. This room will be fitted up in the most up-to-date manner, and south of it will be the ladies' retiring room, the nursery, and the women's pay and free toilets.

The dining facilities will be unsurpassed. That part of the concourse floor directly over the St. Antoine Street corner will be the dining room proper, and opening onto this from the Windsor Street side will be the officials' dining room with the kitchen looking out on St. Antoine Street. Next to the kitchen will be the lunch room. This room will be about sixty feet square, anl will have a large accommodation to the space between the lunch room and the concourse.

Below the concourse floor will be the store rooms, engine rooms, and immigrant quarters. Entrance to the latter will be gained by a large elevator from the concourse and by a side entrance.

Unique heating, lighting and ventilating systems will be installed and the company is arranging for its own supply of drinking water. The architecture of the extension will conform with that of the present building.

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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THE MONTREAL HARBOR.

It will be a matter of regret to many of the visiting engineers representing every important centre in Canada, that during their coming visit to Montreal, to the annual meeting of the Canadian Society, the important construction works in connection with the harbor extensions will be practically closed for the winter.

The engineering features in connection with Montreal Harbor and the continuous progress of its improvements are matters which interest engineers and all other Canadians interested in the building up of this country.

A meeting in the summer season would afford an opportunity of visiting the important works in connection with the improvements to the River St. Lawrence Ship Channel and the modern aids to navigation being vigorously advanced by the Department of Marine and Fisheries of Canada, as well as the splendid scheme of extensions in full swing in Montreal Harbor.

We have asked Mr. Frederick W. Cowie, chief engineer for the Montreal Harbor Commissioners, who for many years had charge of the River St. Lawrence Ship Channel, to prepare an article on the Montreal Harbor extension works. This article will be found on another page of this issue of The Canadian Engineer, and is recommended to the attention of all those who intend to be present at the annual meeting next week, as well as to those who will not have this pleasure.

THE MONTREAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

The Canadian Society of Civil Engineers again hold their annual meeting in Montreal, the birthplace of the society and home of the head office. Last year the meeting in Winnipeg, the first to be held west of the Great Lakes, was a splendid success, and it is to be hoped that this home-coming will also prosper.

The Canadian society has done a great work in drawing together and developing the social and ethical sides of the engineering profession. It comprises in its membership the best from coast to coast, and these men have striven to raise the standard of the profession to the highest point.

The engineering profession has become to-day what might be called a public utility service. The engineer, to be professionally competent, must, as Professor James Scherer so pithily puts it in a recent address to the American Institute of Electrical Engineers, be a man of affairs, versed in business usages, in economics and the history of political reform. Processor Scherer says: "The helpful engineer must be nothing less than a publicist; must not only know his own profession, but must know politics; be in touch with the spirit of the times and able to assist in a proper direction of political reform; but beyond that and above all that he must, in order to do his great work, be, to an extent required of no other profession to-day, a man of known unimpeachable integrity. When you come to the very crux of the matter, the real obstacle in the pathway of your helpfulness to the public is the stumbling-block of doubt, or lack of confidence, on the part of the people in your incorruptibility. I do not question that the character of the average engineer is far above that of the average man in the street; my point is that you must have an extraordinary hold upon the people in order to win their confidence, so that they will give into your hands the solution of obscure and complex problems with which you alone are com-

petent adequately to deal. The very nature of your profession," he continued, "should make possible the attainment of an extraordinarily high standard of character. Take your vocation in comparison with the 'three learned professions,' as they used to be known. The physician necessarily juggles with the credulity of his patient, and plays upon his foibles in order to relieve him of imaginary ailments; thus the physician is open to subtle temptations that may undermine absolute truthfulness of character. The lawyer, by the very nature of the case, must consider solely his client's point of view and become a special pleader, committed by duty to prejudice. Even the clergyman, in order to harmonize the entire body of scriptural teaching, is in danger of quibbling with his exegesis. But it is yours to seek the clear, cold truth, and to declare it without fear or favor. This is the chief glory of science, high priestess of our modern civilization."

It must be the aim of all members of the Canadian Society of Civil Engineers to foster such sentiments as the above. When the individual engineer appreciates that his character and his work must be above the breath of suspicion, then the profession will begin to come into its own. The Canadian society has done much towards raising the ethical standard, but there remains room for still greater effort.

EDITORIAL COMMENT.

We have received a copy of the first issue of the Journal of the Canadian Peat Society. We are glad to welcome this new publication into the technical journal field. Its object is to disseminate information regarding the status of the peat industry in Canada. This society and its organ deserve the support of every power user and fuel user, as well as the owners of peat lands and the manufacturers of machinery for making peat fuel.

* * * *

Moosejaw has appointed a Commissioner of Public Works. Among the applicants for the position were some of our most capable Canadian engineers. However, Moosejaw, with the characteristic loyalty of so many of our public-spirited cities and towns, chose a man from St. Paul, Minnesota. Their appointment of a city engineer will now be awaited with interest. No doubt the gentleman from St. Paul will be able to furnish them with a competent man.

* * * *

The question of an Engineering Standards Committee for Canada is suggested in a letter by Mr. Alfred S. L. Barnes. We agree with Mr. Barnes that it is time such a committee was formed. It is our impression that the Canadian Society of Civil Engineers have been working along this line for some years past. In fact, the Dominion Government, before the last election, acting on representations of the Canadian society, had given assurances that they would establish a Department of Standards and a testing station. There is no doubt that the need of a central organization is urgent, and it is to be hoped that the matter will not be dropped.

* * * *

The letter of Professor H. T. Barnes, printed in this issue under letters to the editor, is of special interest at this particular season. As Professor Barnes states, many of the large hydraulic power companies operating in Canada have little or no provision for ice protection. In the early days of hydro-electric installations, when plants were small and customers few in number, continuity of operation was not so important as it is at the present time. Some of these companies have hundreds of power users and many public utilities dependent on them. Whether it is floe ice, anchor ice or frazil ice conditions, there is usually little or no excuse for serious trouble. With reasonable care in design, by the covering of racks by the provision of ice runs and curtain walls, and by good judgment in the location and design of intake, little trouble need be experienced. It can only be classed as criminal negligence when cities and towns are without car service and light as a result of troubles due to inadequate design.

GENERAL NOTES.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for December, 1911:—

	Depth in inches	Departure from the average of twenty years
Calgary, Alta.	0.2	—0.34
Edmonton, Alta.	0.3	—0.50
Swift Current, Sask	0.7	—0.02
Winnipeg, Man.	...	....
Port Stanley, Ont.	3.2	+0.12
Toronto, Ont.	2.85	+0.24
Parry Sound, Ont.	3.0	—1.66
Ottawa, Ont.	3.1	+0.39
Kingston, Ont.	3.5	+0.66
Montreal, Que.	4.4	+0.58
Quebec, Que.	3.6	+0.44
Chatham, N.B.	3.3	+0.12
Halifax, N.S.	3.4	—0.29
Victoria, B.C.	2.8	—3.47
Kamloops, B.C.	1.6	+0.78

CORRECTION.

In the issue of The Canadian Engineer dated December 7th, we published an article on Molybdenum. The material for this article was abstracted from a bulletin of the Geological Surveys Department of Canada, by Mr. T. S. Walker. Through inadvertence on our part, full credit was not given to the Department and to Mr. Walker. We take pleasure in making this explanation now.

SHUTDOWNS DUE TO ICE TROUBLES.

The Editor:

Sir,—In your issue of January 4th you call attention to the "shut down" of the Dominion Power and Transmission Company from anchor-ice at the intake. For some time I have wanted to draw your attention to the culpable lack of provision made at so many hydraulic works for handling ice. No producer of power has a right to have his works inoperative even a few hours a year when the comfort of human beings is jeopardized. It was sad to see so many valuable plants rendered useless this year by the sudden advent of the cold weather, but this happens year after year with painful regularity. With all that has been said and written on this subject one still sees the exposed rack bars inviting trouble from anchor-ice, and a head race or canal plugged with frazil. How long, may I ask, will it take these big companies to realize the practical value of the modern theories of ice formation, and that

preventive measures based on these are proving such a success in so many places. Careful readers of your valuable journal are certainly not kept in ignorance of modern developments in dealing with the ice question. To-day no power house properly equipped need fear a "shut down" by anchor-ice, frazil or any other kind of ice.

H. T. BARNES, D.Sc., F.R.S.

McGill University, January 8th, 1912.

MOTION PICTURES FOR ENGINEERING LECTURES.

The Editor:

Sir,—Re your editorial comment of 4th inst. on the use of motion pictures to illustrate a recent lecture of the Canadian Society of Civil Engineers, you mention that this is probably the first time they have been used for such a purpose.

It may interest you to hear that this method of illustration was used some seven years ago by the Glasgow Association of the Institution of Civil Engineers, of which association I was a member of council.

At that time moving pictures were not so efficient as they are to-day, but I still retain a most vivid recollection of the works displayed then, and can strongly endorse what you say as to the excellence of the method, especially from the point of view of a man who is trying to teach. Yours faithfully,

R. D. BROWN. City Engineer,

St. Catharines, Ont.

ENGINEERING STANDARDS COMMITTEE.

The Editor:

Sir,—Will you allow me to suggest through the medium of your paper that it is time that Canada had an "Engineering Standards Committee" of her own, something like that which has been in existence in London since 1901?

For the information of those of your readers who are not acquainted with the work and constitution of the British committee, it may be stated that it is supported by H.M. Government, the Institutions of Civil Engineers, Mechanical Engineers, Naval Architects, Electrical Engineers, and the Iron and Steel Institute, as well as by nearly all the leading railway companies, engineering and shipbuilding firms of Great Britain. The India Government also makes a yearly grant.

The work of the committee covers a wide and ever-enlarging field, as the following selection of the titles of some of the already published reports will show:—

Specifications and Sections of British Standard Tramway Rails and Fishplates.

British Standard Tables of Pipe Flanges.

British Standard Specifications for Portland Cement.

British Standard Specifications and Tables for Telegraph Material.

Tables of British Standard Whitworth Threads.

Tables of British Standard Fine Threads.

Tables of British Standard Pipe Threads.

British Standard Specification for Cast-iron Pipe for Hydraulic Power.

The committee also recognizes the necessity of keeping abreast of the times, as is made clear in the following extract from its "Report on Work Accomplished," dated 1911:—

> " . . it is necessary to review from time to time the original standard specifications, and unless this be a recognized part of the work of the committee, the process of standardization might lead to undesirable stereotyping of procedure, checking inventions and impeding improvements."

From Canada's point of view the extract below from the same report is of great significance:—

> "A comparatively new branch of the committee's activities is the co-operation which it has been asked to extend to the subject of International Standardization, and the secretary has attended, in an advising capacity, congresses held at Copenhagen, Brussels and Paris. **One salient feature which has been evident at these Congresses is the advantage which this country enjoys over most of the Continental countries in the possession of a central organization on which all the interests concerned are represented, and to which reference can be made and information obtained as to the reasons which led to the determination of the present British Standard."**

The italics are the writer's, and are employed to give emphasis to the opinion expressed in this portion of the paragraph, more especially in view of the fact that a Canadian Committee of the International Electrotechnical Commission is now in existence and has held its first meeting.

This country, so far, has been content, and perhaps unavoidably, to adopt standards made by other countries without question, but the time is coming, if it be not already here, when there will be British Standards for one thing and American Standards for another, with perhaps a few international ones thrown in. No one will know the why or the wherefore of the Standards. and it is not unlikely that by means of such a haphazard kind of selection the standards which would be the best for this country will, in some instances, be the very ones that are not adopted.

It will not, in many cases, be essential, if an Engineering Standards Committee be formed here, that such a body should itself go over the whole ground of discussion and experiment which has led to the adoption of standards in other countries, but it could, after due consideration of the existing standards of other countries—and having in mind any requirements peculiar to Canada—decide whether to adopt an existing standard or to frame a fresh one. The writer believes that this subject has already been mooted in some quarters, but, as far as he is aware, it has not yet been given any publicity. The proper time for the formation of such a committee is now; its work will be much harder five, or even two, years hence. Government support, both Dominion and Provincial, should be asked from the commencement, and also that of all leading railway companies, engineering societies and manufacturers, telephone and telegraph companies, etc., in the Dominion, as each of them would derive very great benefit from the labors of such a committee.

Another reason for the necessity of prompt action in this matter is the proposed formation of various Provincial Commissions to take charge of "public utilities." These Commissions will probably each begin to formulate their own standards, and in a few years there will be in existence a state of "confusion worse confounded."

Your correspondent would be glad to do anything in his power to further the formation of such a body. Yours faithfully,

ALFRED S. L. BARNES,

Room 512, Continental Life Building, Toronto.

FOUNDATION WORK IN MONTREAL.

By ALEXANDER ALLAIRE, M.E., Manager of The Foundation Company, Limited.

In designing foundations for heavy structures, the engineer has before him in each specific case two problems; first, that the type finally selected shall fulfill all the necessary conditions, and second, that this shall be accomplished with a minimum expenditure of money.

In arriving at the result, both of the above are governed by the following:—

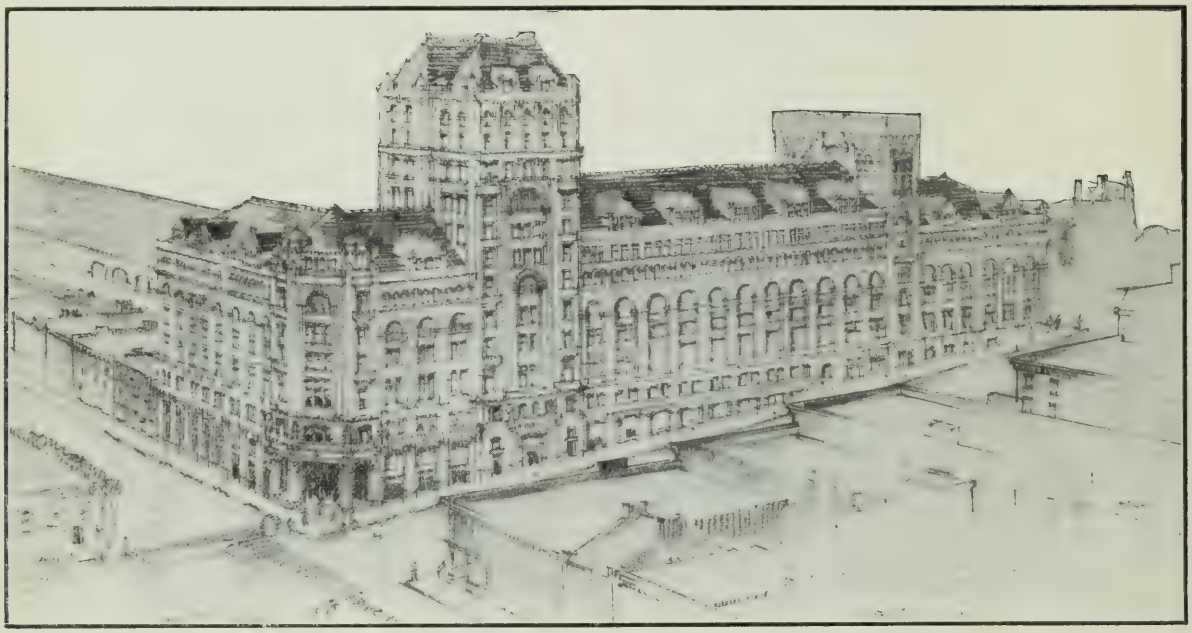
1. The nature of the soil.
2. The depth of rock or satisfactory bottom.
3. The magnitude and distribution of the loads to be supported.
4. The elevation of water level.
5. The depth of the general excavation.
6. The surrounding conditions, including the possibility of future disturbance.
7. The value of the structure to be supported.

precautionary method usually consists in carriyng the foundation to a depth sufficiently great to preclude any possibility of future disturbance.

The recognized types of foundations may be grouped in well defined classes. These are essentially as follows:—

Class 1.—Spread Footings.—Under this head we have (a) timber grillage; (b) plain concrete footings, and (c) reinforced concrete footings. These comprise the ordinary building foundations.

Class 2.—Piles.—This is divided into (a) wooden piles; (b) concrete piles, both those moulded in the ground and those built up and allowed to set before driving; (c) steel pipe driven, interiors cleaned out and filled with concrete. This kind of work is more expensive than the previous class, but often permits building where under the former it would be impossible.



General View of Windsor Station.

The careful consideration of these seven factors must be considered as essential to the successful working out of a proper design.

In item number "six" we have a point to which enough thought is often not given. Frequently the study of the foundation for a structure shows that two types may be used, often one less costly than the other.

Here the fact that apparently the result may be obtained with a smaller expenditure of money would seem to govern. A further investigation of the surrounding conditions, however, often shows that the apparent first saving is not the governing element. The modern tall building, costing as it does, hundreds of thousands and often millions of dollars, makes it imperative that this large investment shall not be jeopardized. When, therefore, the examination of the adjoining properties and neighboring streets indicates the probability of future operations which may endanger the stability and safety of the structure, it is often necessary to accept what appeared to be at first the more expensive design. This

Class 3.—Open Method—Which may be sub-divided into (a) cofferdams of wood or steel sheeting; (b) open excavation followed by timber lining; (c) timber or steel box built up above ground and sunk, (d) monolithic concrete caissons built up above ground and sunk. The foundations are often carried to considerable depth below the ground line.

Class 4.—Pneumatic Method.—(a) Caissons of timber or steel filled with concrete before sinking; (b) monolithic concrete caissons built up before sinking. These foundations are usually carried to rock.

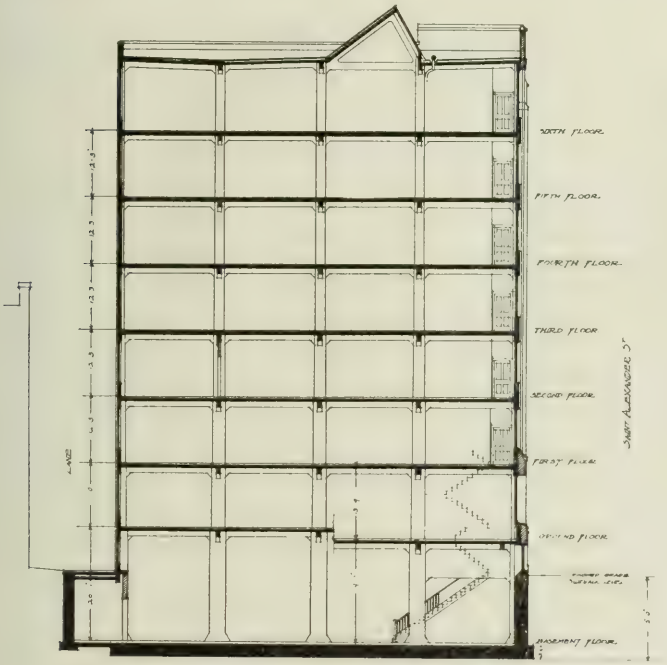
Class 5.—Which consists of a combination of two of the above classes, usually II. and III., or by starting with III. and finishing by means of the pneumatic method.

The city of Montreal, lying in good port between Mount Royal on one side and the St. Lawrence River on the other, presents to the engineer soils of widely varying character. We are told that ages ago this section of the country formed a part of the Gulf of St. Lawrence, and at that period the water level was practically at the top of Mount Royal. As

the centuries passed this water receded, during certain periods more or less rapidly, while at others it remained practically stationary. The periods of stationary and falling water levels were clearly shown by well defined beach or shore lines found in recent investigations.

As a result of the above, the blanket of earth, covering the rock underlying Montreal, is not a uniform quality over the whole area of the city. Usually the rock is found to be overlain with a shallow layer of boulder clay left from the glacial period, while over this the soil is of various natures, depending upon the localities. Excavations in various parts of the city show this to consist of loam, sand, gravel, soft and medium clays, as well as quicksand and a silty clay resembling quicksand.

The upper stratum of limestone underlying the city is also worthy of consideration. In constructing the foundations for certain buildings, whose weight made advisable the carrying of the piers to rock, The Foundation Co. found the upper surface of this rock to be badly shattered, necessitating the excavation of same in some instances for a number of feet



Section Through Herald Building, Montreal.

before a satisfactory bottom could be secured. This, geologists tell us, is due to the upheaval at the time that Mount Royal, formed by some volcanic eruption, burst its way through the overlying rock strata.

As a result of the varied character of soils to be encountered in the different parts of the city, we find many different types of foundations. A great majority of the buildings having moderate height and loading are carried on spread footings. These are to be seen daily in the course of erection and need no further comment.

There is one type of structure, however, which while it comes under this class, is not common to Montreal. This is exemplified in the Herald Building. The building in question is carried on what is known as a floating foundation; that is, the columns, instead of each being carried on an individual footing, are all set in one immense footing or mat, which covers the whole area of the lot. The reinforced concrete mat, 2½ ft. thick, at the Herald Building is built on a bed of gravel overlying black sand of considerable depth. The idea of spreading the footing, as mentioned, was to reduce the load per square foot, the loading of the soil in this case being estimated at one ton per sq. ft.

In certain sections of the city wooden piles have been used in the foundations, as these were thought to meet conditions satisfactorily. Along the harbor front several structures are carried on concrete piles, both the moulded in the ground and built-up types having been used.

At the Montreal General Hospital we have a more difficult class of foundation work. Here the open method was

Driving Steel Sheeting, General Hospital, Montreal.

used, steel sheeting being driven and the excavation made inside same down to hard pan. These piers were circular in form, though of varying diameter. The sheeting was driven to depth with both steam and drop hammers. To facilitate handling these and the pieces of steel sheeting, four stiff-leg derricks were set up at different points on the lot. On this work the average distance from the lot, as excavated, to the hard pan on which the piers were started, was approximately 30 ft.

The Windsor Street extension is another example of the open method, differing, however, in manner of execution from that just described. This work comprised the construction of approximately 300 piers, a few rectangular but most of them circular in form. The Foundation Co. started on this work the latter part of November, 1909, and finished

Windsor Station Extension, Work in Progress.

about June 1st, 1910. This is particularlyy noteworthy when the season of the year, during which the work was carried on, is considered.

The pier excavations in this instance were made by open digging and lining the sides of the wells with wooden lagging, which was held in place by iron bands. The material was hoisted to the surface in buckets by means of a revolving winch head mounted on a tripod at the top of each well. The pits were excavated in sets of from 7 to 9, each row having a hoisting engine, which by means of an endless cable, furnished the power to turn the winch heads. Five complete outfits of hoisting engines and tripod sets were used, so that while 4 rows of holes were being operated a fifth could be prepared. This precluded any loss of time as the gangs coming out of the completed piers immediately started in on the row of holes which had been made ready.

On this site, as the excavation of a great number of piers was completed, and the rock bared, it was found that its upper surface was broken up by very noticeable cracks. It was, therefore, necessary to remove this faulty material down to a sound strata. In some instances the excavation was carried to a depth of twelve feet before a satisfactory bottom was secured.

At the Dominion Express Building, corner of St. James and St. Francois Xavier Streets, we have an example coming under Class IV. Here The Foundation Co. sank pneumatic

Dominion Express Building, Montreal.

caissons to rock, each forming a pier on which rested one of the building columns. These caissons were built with wooden walls filled with concrete. As the work was carried on during the winter of 1910-1911, these walls protected the concrete from the cold weather. The setting up of the concrete was further aided by hanging salamanders, in which fires were kept burning, in the interior of the caisson shaft. The total number of caissons sunk was 42.

The depth of rock was found to vary somewhat over the lot, the deepest caissons reaching same at a distance of 90 ft. below St. James Street curb. The extreme dimensions of the lot were 120 ft. by 95 ft. It was bounded on three sides by streets and on the remaining side by the Royal Bank. On account of the columns along the Royal Bank being very close to the building line, it was necessary to set these caissons back the necessary distance to clear the wall. The new columns then being thrown off the centre of the piers, were cantilevered by means of girders composed of 24-inch I beams extending from these caissons to those in the next row from the building.

On account of the excavation having to be carried below the footing of the Royal Bank, it was necessary to take care of the building while the work was carried on. This was very successfully done by means of long inclined pushers, these being adjusted to preclude the possibility of any settlement.

At this building, also, the upper surface of the rock was found to be badly fractured at a number of the pier sites. This condition did not extend over the lot, being confined to the northeast corner. Wherever this was found to exist, however, the rock was taken out under air by means of blasting, assisted by bull points and wedges.

The modern tall building, representing, as it does, such a large investment of capital should receive very exhaustive study before any particular type of foundation is decided upon. It is in this connection that the taking of careful borings or sinking of test pits is strongly recommended. In underground or sub-aqueous work the unknown is always likely to prove a large factor. Borings or test pits carefully made and the records obtained carefully read, will often cut down the unknown contingencies and thus aid in the design of a proper and lasting foundation.

MEETING OF CANADIAN RAILWAY CLUB.

The Canadian Railway Club held a meeting at the Windsor Hotel, Montreal, on Monday, December 18th, 1911.

Mr. E. B. Tilt, engineer of tests, Canadian Pacific Railway, read a paper on "The Work of the Testing Department of a Railway." In the opening of his paper he drew the attention of his audience to the early history of the steam railway and gradually working up to the importance of his title, showed that the management of the Canadian Pacific Railway had early recognized the value of a railway testing department, and since 1891, when W. Bell Dawson started the first laboratory, with Milton L. Hersey as assistant chemist, there has been a department of some magnitude, greater or less, depending upon what purchases of supplies were being made. Within the last few years there has been a division of the system into western and eastern lines, the former of which has had its own chemical laboratory at Winnipeg since 1905, which has specialized in water troubles with much success, in addition to doing the other routine work which comes to a railway chemical laboratory. The work on eastern lines is done conjointly, by commercial testing companies who do all of the foreign mill inspection; Dr. Milton L. Hersey and associates, of Montreal, who do all of the chemical work; and the testing department with laboratory at Angus shops, who do a portion of the domestic mill inspection, and who take charge of the routine sampling and inspection of materials received at the Angus shops, where are located the locomotive and the car departments and the general stores. The duties of the Angus shops testing department include also the preparation of suitable specifications, the investigation of the failures of materials and the studies of processes or special materials. The testing of devices is handled by the mechanical engineers of the locomotive or the car departments.

In the purchase of materials of such wide variety and origin as are required for the C.P.R. the question of economical inspection is important and the present organization has been found to be a satisfactory and cheap one.

The president, Mr. A. A. Goodchild, was in the chair.

THE MONTREAL FILTRATION WORKS.

By FREDERICK E. FIELD, Resident Engineer.

Historical.—The present water supply of the city is drawn from a shore intake about two miles above Lachine Rapids. It is a mixture of waters from the St. Lawrence and Ottawa Rivers, which above this point have a combined drainage area of about 570,000 square miles and a combined population of 172,000 contributing sewage to the rivers. The extension of the intake to a point 1,200 feet from shore is now under contract.

The water is conveyed to the low level pumping station at Point St. Charles, a distance of about five miles, by an 8½-ft. concrete conduit which parallels the power aqueduct which delivered water to the wheels of the original pumping station.

At the Point St. Charles pumping station five steam pumps are in service to elevate the present daily consumption of 44,000,000 gallons to the distributing reservoirs of the city. The municipal plant supplies a population of about 350,000, and the remaining 200,000 residents of the city are supplied by The Montreal Water & Power Company, a private corporation, which is now completing a filter plant of 20,000,000 gallons daily capacity.

Owing to the striking increase in the number of typhoid cases which happened towards the end of the year 1909, the newly-elected Board of Commissioners at the beginning of 1910 decided to confer with experts of high repute as to the study of the present and possible sources of supply of the aqueduct of Montreal. Meantime, on February the 8th, 1910, the treatment of the municipal water supply by hypochlorite of lime was started and has been regularly continued up to the present time.

On April 4th, 1910, Messrs. Hering & Fuller. consulting engineers, of New York city, were instructed to report on the best means of securing an improved water supply for the city.

On July 2nd, 1910, the consulting engineers submitted their report and recommended double filtration of the St. Lawrence River water. This recommendation was adopted by the city, and Messrs. Hering & Fuller were engaged to cooperate with Mr. George Janin, chief engineer, and Mr. T. W. Lesage, engineering superintendent of waterworks of the city, in preparing contract plans and specifications, and in supervising the construction of filtration works for the city of Montreal.

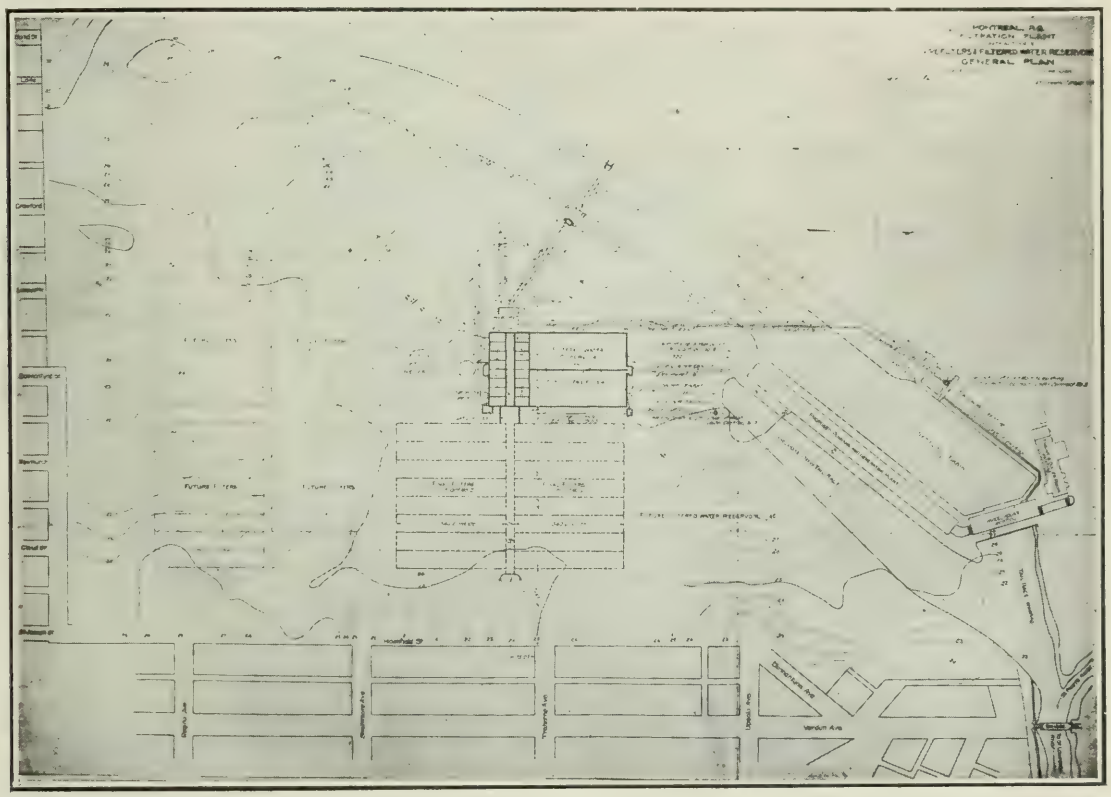


Fig. 2.

The work has been divided into four contracts, in order to facilitate the rapid and economical completion of the project.

Contracts.—Contract No. 1, for the pumping machinery, blower, and cranes was awarded on August 9th, 1911, to the British Electric Plant Co., of Alloa, Scotland, for the lump sum of $40,250.

Contract No. 2, for the final filters and appurtenances, was awarded on August 16th, 1911, to F. H. McGuigan, of Toronto, for the lump sum of $673,000.

Contract No. 3, for the prefilters, filtered water reservoir and appurtenances was awarded on 16th December, 1911, to F. H. McGuigan for the lump sum of $485,000.

Contract No. 4, for the pumping station, wash water tower, and the superstructures of the various buildings and gate chambers, has not, as yet, been placed under contract.

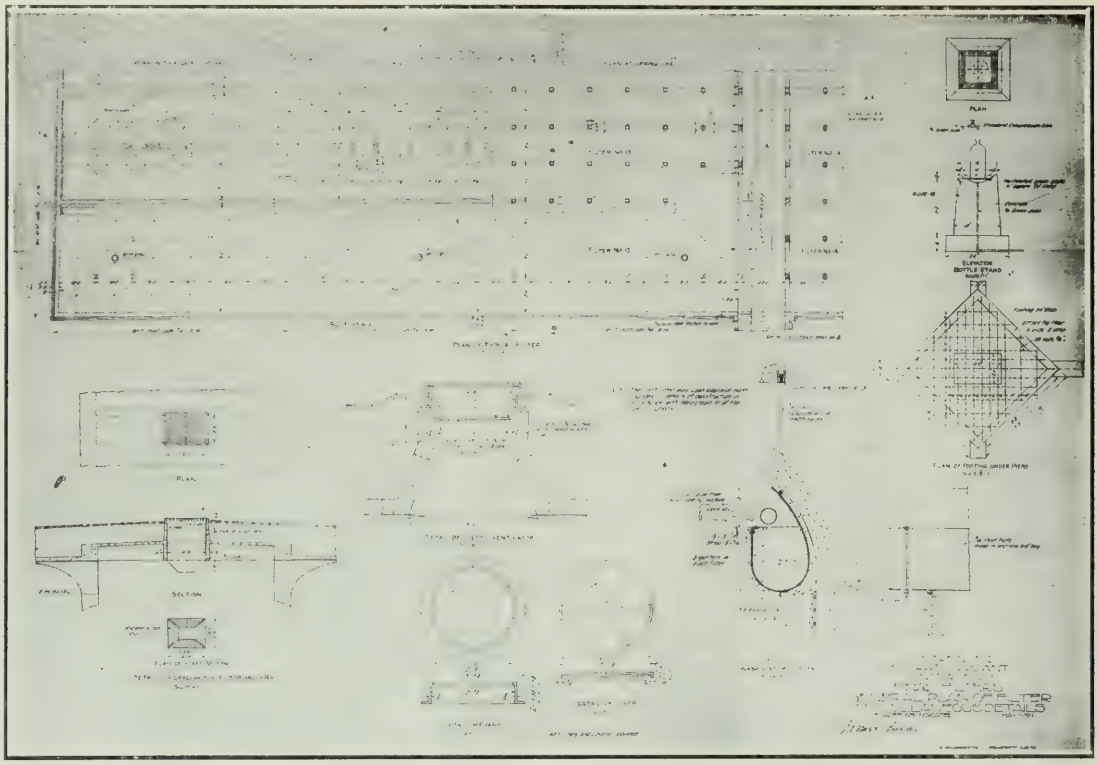
The work will be built on land in the town of Verdun and adjoining the city water works property at Point St. Charles. The general arrangement of the several parts of the work are shown in Fig. 2.

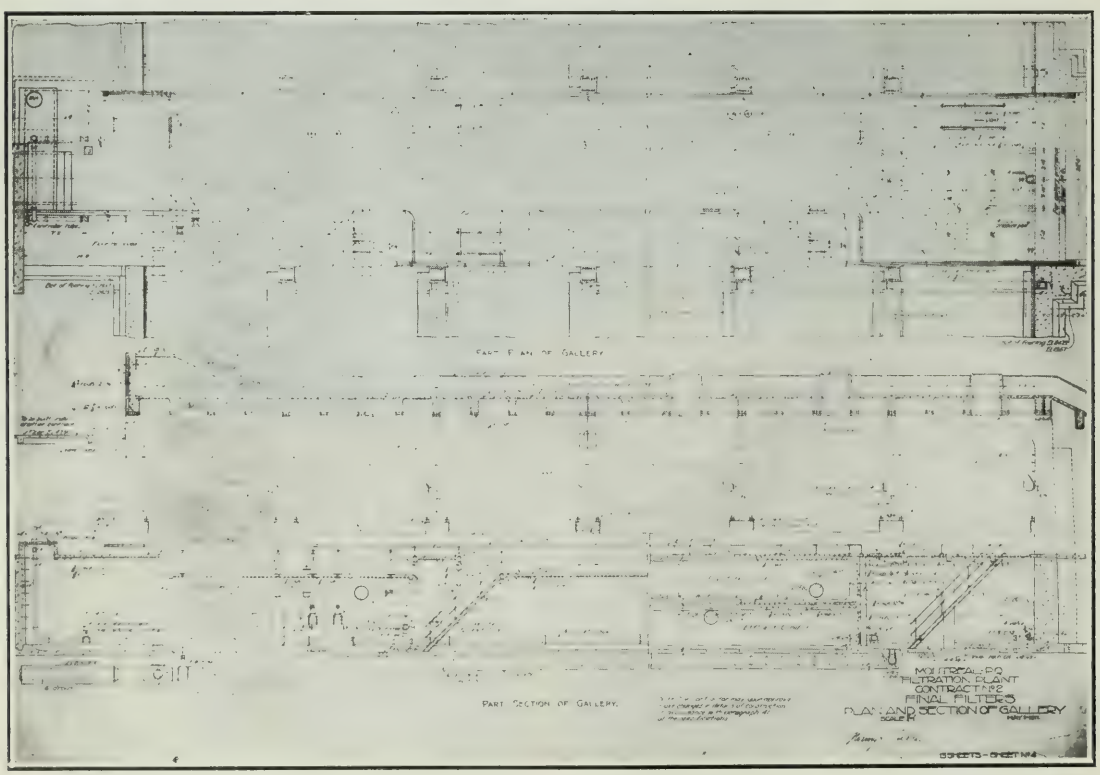
The present construction is designed for a daily capacity of 50,000,000 imperial gallons (60,000,000 U.S. gals.), and will serve about 350,000 people. Sufficient land has been acquired, and provision has been made in the present plans for enlarging the works, as required by future needs, to an ultimate daily capacity of about 150,000,000 imperial gallons.

Contract No. 1—Pumping Machinery.—This contract includes:—

Two raw water pumps, unit capacity 17,500 imperial gallons per minute.

Two raw water pumps, unit capacity 17,500 imperial gallons per minute.





Figs. 3 and 4.

Two raw water pumps, unit capacity 5,800 imperial gallons per minute.

Two wash water pumps, unit capacity 1,300 imperial gallons per minute.

Two sump pumps, unit capacity 330 imperial gallons per minute.

Two sump pumps, unit capacity 150 imperial gallons per minute.

One rotary blower, unit capacity 5,000 cubic feet of free air against five pounds pressure per square inch.

Two cranes, hand operated, each six tons capacity.

Switchboards, transformers and appurtenances.

All pumps are horizontal, except the sump pumps, and all, together with the blower, are driven by direct connected three-phase 60-cycle alternating current motors.

The voltage for the 8 largest pumps and the blower will be approximately 2,200. That for the remaining 6 pumps will be approximately 550.

The ordinary lift for the raw water pumps is 18 feet, for the wash water pumps 46 feet, and for the sump pumps 15 feet. The raw water pumps receive their supply from a connection with the present raw water conduit previously mentioned, and have no suction lift.

Contract No. 2—Final Filters and Appurtenances.—The final filters are 16 in number and are arranged in batteries of 8 on either side of an operating gallery. The filters are covered by groined arches, supported on piers spaced on 19 feet centres. The floor is flat and so constructed that the pier load is carried on foundation blocks, independent of the rest of the floor. The filters are 55 by 340 feet inside, with the short dimensions adjoining the gallery to accommodate the design to the use of the Blaisdell washing machines, which will run from the gallery to the extreme end of the filters upon tracks carried by concrete beams between the filter piers. The underdrainage system consists of two half-round 8-inch laterals in each bay, which discharge into a central main collector, 2½ feet in diameter, extending the entire length of the filter and below the filter floor.

The filtering material comprises 12 inches of gravel and 27 inches of sand.

The gravel will be placed in four layers. The lower layer, 5 inches thick, has particles varying from 2½ to 1½ inches in size.

The second layer is 3½ inches thick and varies from 1½ to ½ inch.

The third layer is 2 inches thick, with particles from ½ inch to 9/32 inch in size.

The fourth layer is 1½ inches thick and has particles from 3/16 inch to 5/64 inch in size.

The filter sand will vary from 0.25 to 0.36 mm. in size.

The filters receiving their supply from the prefilters to be built under Contract No. 3, will operate at a rate of 10,000,000 gallons per acre per day, thus giving each of the 16 filters an output of 3,750,000 gallons per day.

The operating gallery, with a clear span of 22 feet, contains the prefiltered and filtered water conduits and the necessary pipe connections to the filters.

The side walls carry tracks upon which a transfer table, for conveying the washing machines from one filter to another, will be operated.

The filters and gallery are lighted by electricity, and the gallery also has skylights for natural illumination.

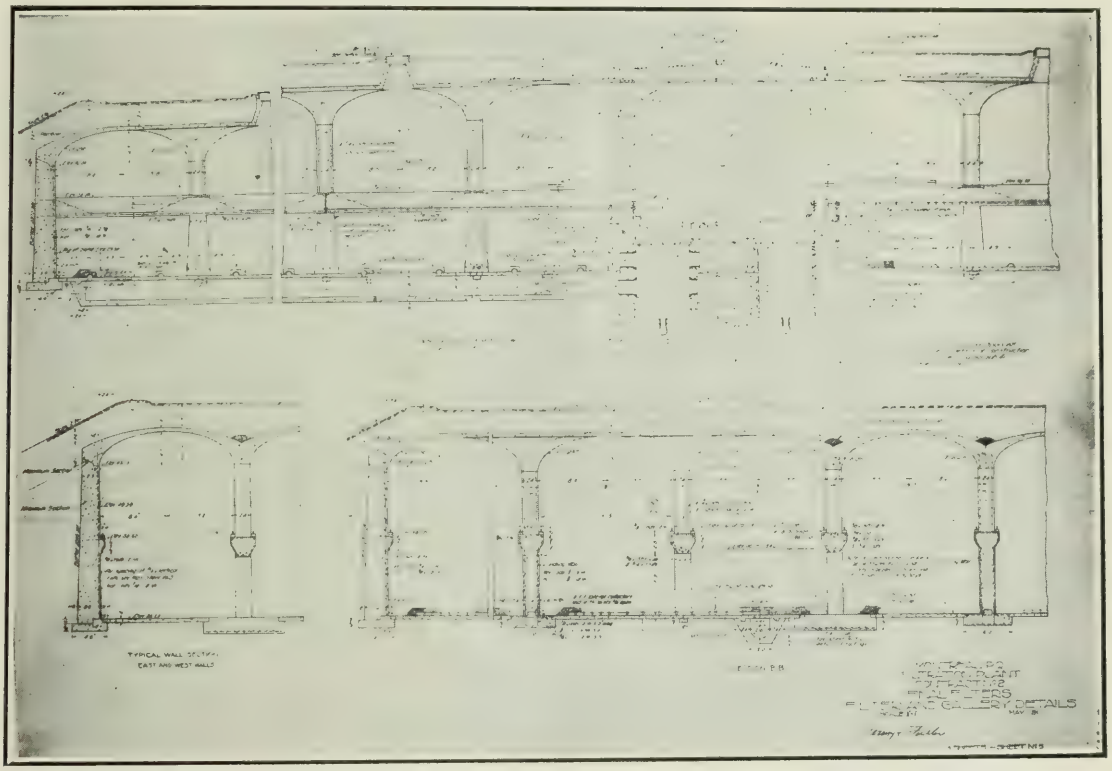


Fig. 5.

A heating and ventilating system will be installed to prevent the formation of skim ice on the filters during cold weather, and to make the filters and gallery hygienic for workmen at all times.

From a fan, with a capacity of 65,000 cubic feet of air per minute, installed in an adjoining gate house, the air electrically heated will be conveyed in plaster ducts along the end walls of the filters. Between each row of piers an opening with an adjustable door will allow the heated air to pass into the filter.

On each side of the gallery and in the arch of the filter roof a similar duct takes the air back to the fan.

Electric radiators are also provided in the lower part of the gallery to prevent the freezing of gauge and controller piping.

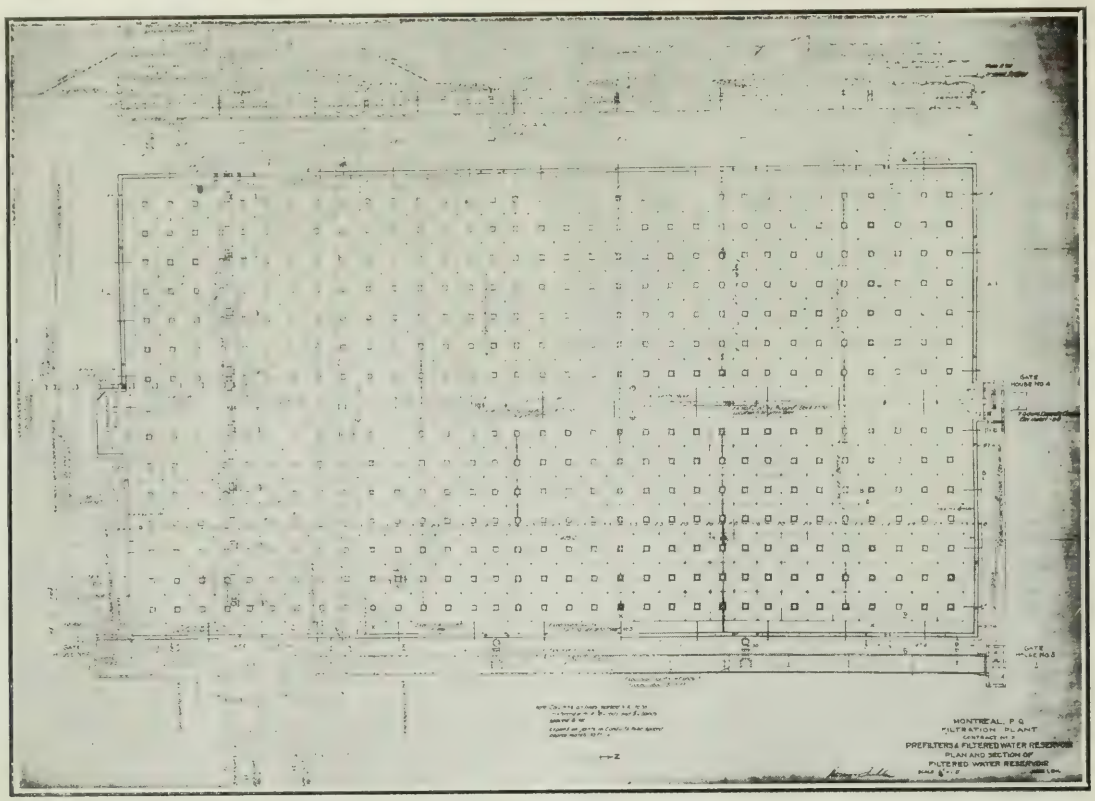
Figures 3, 4 and 5 give many details of the design of the final filters.

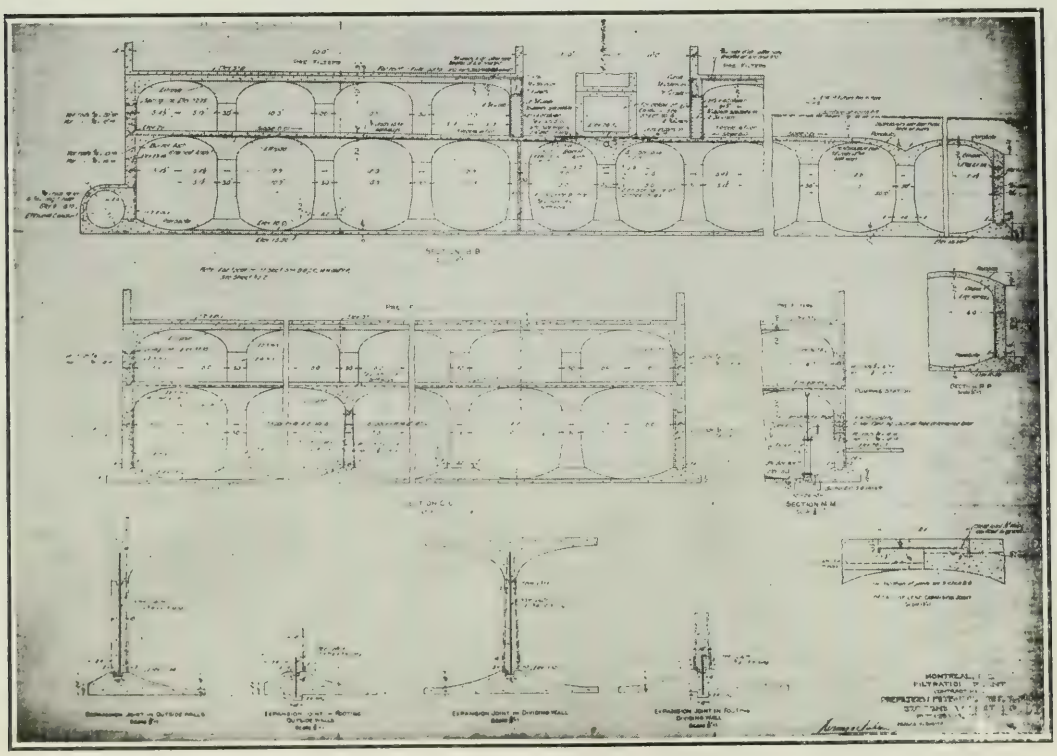
Contract No. 3—Prefilters and Filtered Water Reservoir.—The prefilters and filtered water reservoir are to be built just west of the final filters, and between them and the aqueduct.

The filtered water reservoir is of concrete, with groined arches for the roof and inverted groined arches for the floor.

ed on each side of the operating gallery, which is practically a continuation of the gallery of the final filters.

The floors of the prefilters are carried by a second series of groined arches, 8 feet above the roof of the filtered water reservoir.





Figs. 6 and 7.

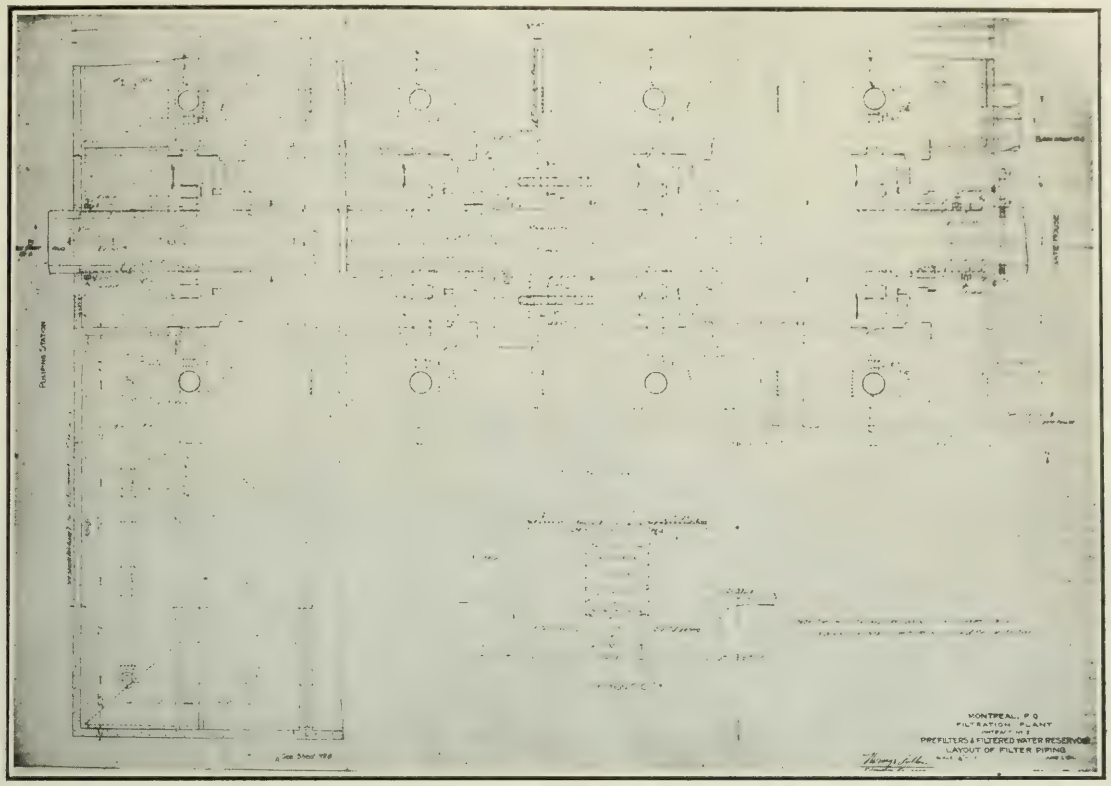
It is 429 by 232½ feet in size, and has a capacity of 7,500,000 gallons. The roof is designed to take the load of the present and future installations of prefilters. The prefilters now under contract are 16 in number, and are arrang-

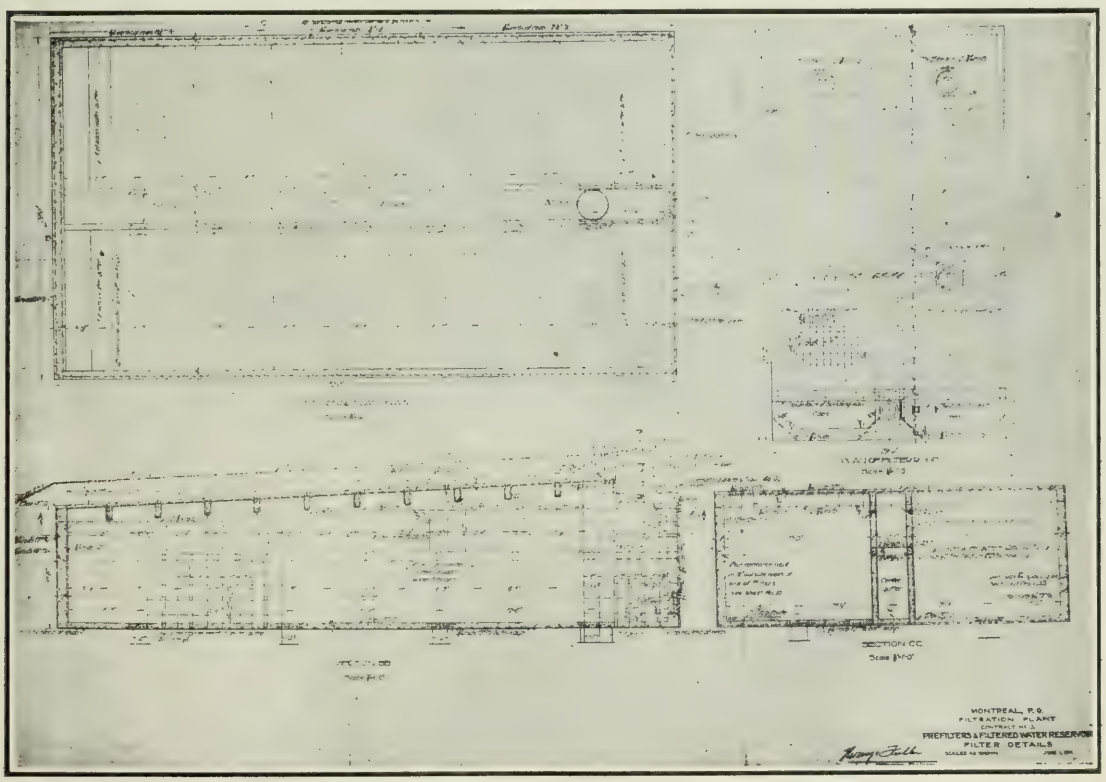
Each prefilter has an effective sand area 50 by 24 feet, which is divided longitudinally by a central wash water gutter, the sides of which extend above the normal water level of the filters.

Each prefilter has 8 lateral wash water gutters on each side of the central gutter.

The filtering material consists of 8 inches of gravel and 30 inches of sand.

Each prefilter will be equipped with a strainer and air system. Water for washing will be supplied from the wash water tower, to be built under contract No. 4, and fed by duplicate motor driven pumps, already mentioned under the





Figs. 8 and 9.

The gravel will be placed in four layers, varying in size from 1 inch in the lower layer to about 0.1 inch in the top layer.

The sand will have an effective size of from 0.50 to 0.60 mm.

description of Contract No. 1.

The air will be supplied by the rotary blower, previously mentioned.

The prefilters are designed to operate at a rate of about 136,000,000 gallons per acre per day. Each filter unit will

be equipped with a rate controller, which will allow the passage of 3,750,000 gallons daily, the same rated capacity as each of the final filters.

The operating gallery contains the influent and effluent conduits, piping connections, and the operating tables from which all operations for the regulation and washing of the filters are accomplished by means of connections to hydraulically operated valves.

On this contract as well as on contract No. 2, all piping or conduits larger than 30 inches in diameter, are of reinforced concrete.

All work has been designed with the idea of the greatest possible elasticity in operation.

Either the prefilters, final filters, or filtered water reservoir could be put out of service if desired, and the building of such extensions of the works as the future may require can be accomplished without affecting the capacity of the present plant.

Figures 6, 7, 8 and 9 give details of reservoir and prefilters.

Contract No. 4—Pumping Station and Buildings.—This contract, not yet executed, will include the pumping station, the wash water tower, and the buildings over the operating gallery of the prefilters and over the gate chambers.

The buildings will be of concrete or brick, with either red or green tile roofing laid upon roofs of cinder concrete.

The roof trusses will be of structural steel shapes.

In the wash water tower, equipment will be installed for the treatment of the filtered water with hypochlorite of lime, if such treatment is required after the double filtration of the water.

Part of the main floor of the pumping station will be fitted up as a chemical and bacteriological laboratory.

The building will be heated, if required, by electric radiators.

Associated Work.—A hydro-electric pumping station will be built on the east bank of the enlarged aqueduct, near the old wheel house.

This station will furnish electric current to run the pumps and machinery, and to light and heat the several units of the filtration works. It will also receive the filtered water from the works, and pump the same to the distributing reservoir of the city.

As all the filters and the filtered water reservoir are covered with earth and seeded, it is proposed to construct roads and paths about the works, plant trees and shrubbery, and, in fact, create a park which will compare favorably with the other parks in the city, and be beneficial to the people in this vicinity.

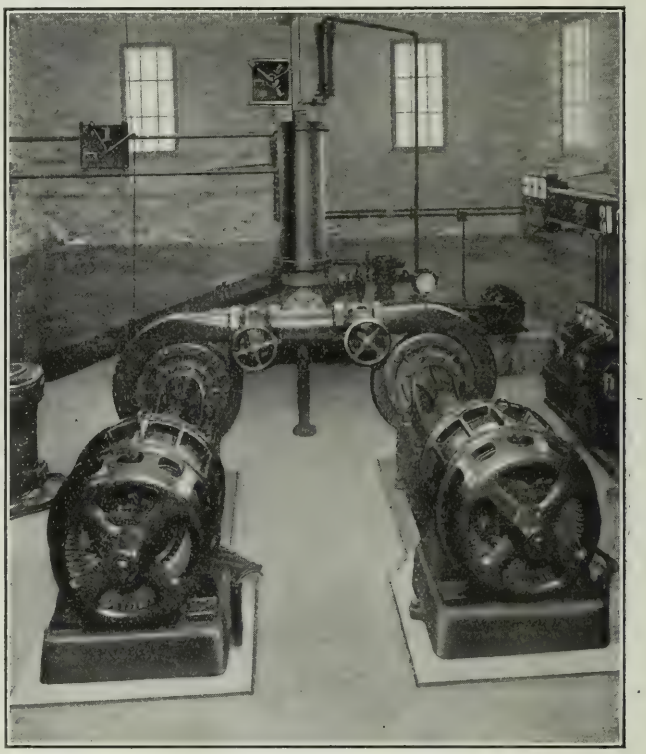
UNIQUE SEWAGE PUMPING PLANT.

One of the first obvious uses discovered for the centrifugal pump was the handling of water containing foreign elements that would either become lodged in the intricate passages of a reciprocating pump or be caught by the closing valves, allowing the pump to lose its suction. In modern sewage pumping stations, therefore, the centrifugal is preferred, as all foreign matter will readily pass through it.

The Sunnyside Avenue sewage pumping plant of the city of Toronto is unique. It is located at the foot of Sunnyside Avenue, on the lake shore, and drains a section of the city whose level is below that of the main trunk sewer running east and west. The difference in elevation between the bottom of the reservoir from which the sewage pumps take their water, and the main sewer is 44 feet, which requires, however, 620 feet of 8-inch pipe. The reservoir occupies the basement of the pump house, and is entirely under ground. It measures 18 feet by 18 feet, and is 10 feet deep, having a capacity of 20,000 imperial gallons.

It was possible to estimate closely the ultimate population which this station would ever be called upon to take care of, and the necessary pumps were installed in duplicate, in order that the station might never be shut down, in case one unit needed overhauling. The station being small and isolated, as far as similar city equipments are concerned, the plant was designed to (1) automatically prime its own pumps; (2) to start pumping when the water in the reservoir had risen to within one foot of the pump house floor, and (3) to stop the pumps when the reservoir had been pumped out

The main equipment consists of two 6-inch special centrifugal sewage pumps, built by the John McDougall Caledonian Iron Works Co., Limited, of Montreal. Each has a capacity of 800 imperial gallons per minute, and is direct connected to a 40 h.p. induction motor. These pumps are started and stopped by Cutler-Hammer relay starters, operated by floats that rise and fall with the level of the water in the reservoir. As the pumps operate automatically, it was considered good practice to provide considerable reserve power to allow for any possible variation in head.



Sunnyside Pumping Station.

Heretofore the city has used vertical submerged centrifugal pumps, but owing to the difficulty of reaching them if they ever required attention, and the desirability of having machinery where it could be frequently inspected, the engineers decided in favor of the horizontal type placed on a concrete floor above the reservoir, so that the motors would be in a perfectly dry location. As foot valves could not be used on the suction line to keep the pump primed, due to the fact that foreign matter contained in the water would lodge in the valve seats and prevent them from closing special device was designed which goes into operation just before one of the main sewage pumps, primes the pump, and holds the priming until the pump is in full operation. A discharge air chamber contains a set of floats which operate at the proper time, causing a small vacuum pump to exhaust

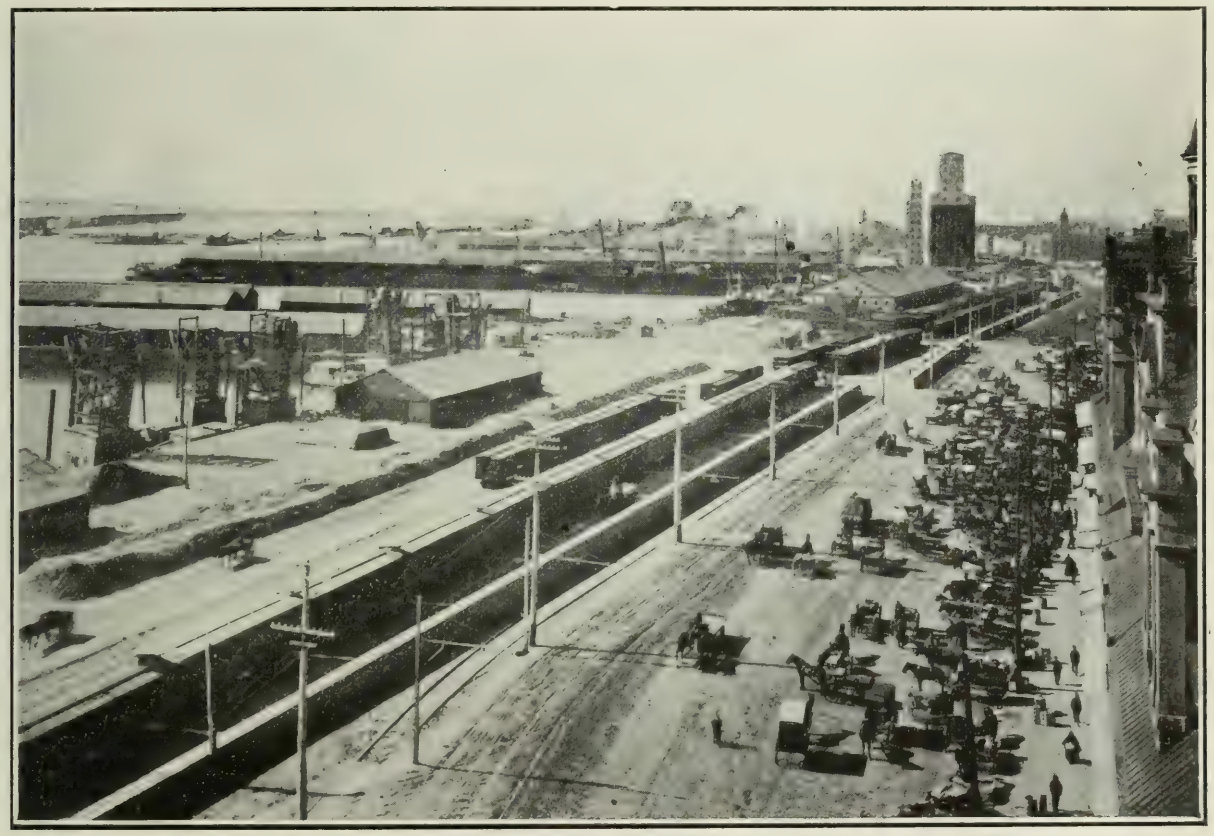
the air in the pup casings, thereby sucking up the necessary priming water from the reservoir below.

This station has now been in operation about six months and the only attention it has received is from an attendant who makes a daily inspection and sees that the oil wells do not run dry.

THE CANADIAN NORTHERN IN MONTREAL.

If a stranger were to inquire in Montreal to-day what had been the most interesting issue discussed during the year the reply would in all probability be: The Canadian Northern and its tunnel right of way into the city.

There is not any doubt about its being the most interesting piece of gossip bandied about among the odd half million inhabitants of the eastern metropolis, and it may also be fairly declared that the problem which the Canadian Northern Railway engineers have set themselves to solve is really the biggest to confront any railway in any city in Canada.



A View of Montreal Harbor.

The tunnel idea of an entrance had always, in the past, been accepted as but a remote possibility by the average railway engineer. True, the subject has probably been often discussed in the executive councils of other roads, but the thing seemed so stupendous an undertaking that it never advanced to the detailed stage, and the railways were quite content to do the best they could with the facilities they had. The Canadian Northern, however, fresh from the conquest of the western prairie, and with the determination born of a transcontinental idea urging on its men, faced the difficulty not with the "impossible" impression, but with the solid conviction that a tunnel was the only proper solution to the problem of an entrance into the heart of the city of Montreal. Mount Royal, while one of the city's most splendid assets, and prominent in Canadian annals since the very inception of the country, is undoubtedly also one of its greatest handicaps. It is not possible for any one to conceive of the city growing over the mountain, and consequently the latitude for growth had been always limited from that fact. The residences of its citizens may flank it but the limited speed of its surface traction line does not make this very desirable. The danger of congestion, for that reason became steadily more imminent.

When the first hint of the Montreal programme by the C.N.R. running into many millions was flashed over the wires to the inhabitants of that city, speculation and curiosity were born. But it is safe to say that no citizen of the eastern city dreamed even of the undertaking which is now taking shape for an entrance through the mountain. The problem was discussed in clubs, hotels, on the streets, and in every place where people congregate. It was, of course, impossible for the executives of the Canadian Northern to announce the beginning and the end of the Montreal scheme, for the difficulties always attending upon the securing of railway right of way, and of rights to do this or that, would have been increased tenfold. On no single occasion during the past year when it was necessary for Sir William Mackenzie, Sir Donald Mann, Mr. D. B. Hanna, or Col. A. D. Davidson to visit their city, did the representatives of the Montreal newspapers forget to ask subtly worded questions as to the scope of the programme which the Canadian Northern had in mind for the city. The direct answer, hoped for but hardly expected was never given, and even to this day it is not on the cards for the citizens of Montreal to understand fully the Canadian Northern entrance in detail.

As the case stands to-day Montreal without taking thought has been increased both in dignity and importance. Its borders have been enlarged and a new garden city is rapidly taking shape behind that beautiful mountain. Mr. F. G. Todd, a landscape surveyor of the city, noted for the

excellent harmony which he has worked out in other subdivisions both in the east and the west, is busy at the present moment working out in comprehensive detail, a beautiful suburb which is to stretch from Mount Royal through to the Back River. The residents of this new subdivision will undoubtedly be highly favored, for it will be quite possible when the tunnel is constructed for the business man to leave his office in the heart of the down-town district and be set down close to his home in anywhere from eight to fifteen minutes. Only the tube, which it is proposed to burrow beneath and through the mountain could make this possible, and in this connection it is safe to say that the sale of the land in question will go a long way towards meeting the initial outlay necessitated by such a large engineering programme. In the five thousand acres at the back of Montreal and in the city property which it was necessary to secure the Canadian Northern has already expended something like ten million dollars. The cost of the engineering work necessary on the tunnel, which is to be three miles in length, and for the elevated tracks in the city which will give the railway access to its steamship wharves, will probably run into ten or fifteen more, so that the entire Montreal undertaking may cost in the neighborhood of twenty-five million dollars. The engineering features consequent upon building such a long tunnel dwarf all the other details of the scheme.

In order that the Montreal project as an entity may be fully understood it is necessary to hark back into recent railway history, as far as this railway is concerned, and show some of the circumstances which have made some such proposition inevitable and imperative. The Canadian Northern Railway, proper, is located in the west, in that part of Canada which extends, roughly speaking, from Port Arthur, in Ontario, to Edmonton in Alberta. There are in those four provinces about forty-five hundred miles of road in actual operation. There are three main lines running east and west in the prairie provinces with a net-work of branch lines connecting these from the north and south, and the railway company has succeeded in girdling with steel the richest section of the western country. This road was born in 1896, and it may be said that at that time the vision of a transcontinental line connecting the Atlantic and the Pacific was also conceived in the minds of the two great founders of the Canadian Northern system. A few years ago the Canadian Northern started the construction of a line from Toronto to Sudbury—a thing apart from the western system, and apparently doomed to do only a local business. In Quebec the Great Northern Railway of Canada was taken over and extended until it connected the cities of Montreal and Quebec, under the name of the Canadian Northern Quebec, while the other line in Ontario was called Canadian Northern Ontario Railway. But these two were still widely separated in fact. Fresh in the recollection of Ontario people at least, was the awarding of contracts for a line of road connecting Toronto and Ottawa. Then there was another contract awarded to a Montreal contractor for a line skirting the Ottawa River and linking together the capital city of Ottawa and the port of Montreal. Both of these two roads should be completed during 1912, and through trains should be running between Toronto and Quebec, and from Toronto to Sudbury and beyond by the end of this year. Thus the process of welding the eastern units together has been proceeded with and the transcontinental idea takes on more definite shape.

Now the contracts to link up the lines between Sudbury and Port Arthur, and for another line to run westerly from Ottawa to connect with the Toronto-Port Arthur line have been awarded and work on both may be said to have fairly commenced. In the west construction men are already working on the remaining section of the transcontinental between Edmonton and Port Mann on the Fraser River. All of these contracts are to be completed by the close of 1913, and so much is the element of speed being considered that 9,000 men are engaged this winter on preliminary construction work in these two widely separated cities.

This brings us to the essential need of a proper terminal in Montreal City. In many interviews the various officials of the Canadian Northern have stated emphatically that the project in that eastern city would be finished by 1914. This means that the Montreal terminals will be ready for operation by the time through transcontinental trains will be running across the continent on Canadian Northern steel. The continuity of purpose marking the letting of all these contracts becomes at once apparent.

The terminal idea in Montreal was almost inspired. For a long time the company's engineers have been worrying over the securing of a plan in Montreal which would be in keeping with the dignity of a continent-wide line. The Mountain, to them was a very tangible obstruction, and it was felt that only under great difficulties would a suitable terminal be secured. Outside of Montreal surveys were run by the score, and it was only when desperation compelled that the idea of approaching the city from the Back River and tunneling under Mount Royal was proposed. To Mr. H. K. Wicksteed, the chief locating engineer of the Canadian Northern, will probably fall the honor of conceiving this radical venture. Colonel A. D. Davidson, Land Commissioner for the company, became enthusiastic over the project, and the possibility of the new subdivision back of the Mountain to the Back River was then born. This section of country would not only afford the company an ideal site for the location of terminal shops and yards, but it would also give to Montreal an opportunity for growth hitherto undreamed of.

Colonel Davidson, immediately the sanction of the executive was secured, began to plan the best methods of securing this territory and the necessary right of way in the city without exciting unduly the curiosity of the holder. The securing of this ten million dollars worth of property stands to-day as a remarkable achievement and is a striking testimonial to a man whose name is already writ large in land matters in Canada.

After all, the engineering difficulties will not be exceedingly great. The line will pass through the suburbs on a gentle rise of about forty feet to the mile, and from that entrance the tunnel will slope citywards at a gradient of about thirty-five feet to the mile, nosing out practically in the business district, for it will run at a considerable depth below what are now some of the principal streets of the city. The building of a palatial station and hotel are only incidents from the engineer's standpoint. The complete plan is not yet advanced sufficiently to allow a proper technical treatment in this paper, and will be considered in a later article.

PERSONAL.

Mr. W. D. Neil, recently of Calgary, has been appointed city manager of C.P.R. telegraphs at Winnipeg, Man.

Mr. J. C. Breithaupt has again been elected chairman of the Water Commission of Berlin, Ont., for the thirteenth term.

Mr. L. W. Rundlett, of St. Paul, Minn., has been appointed to the commissionership of Moose Jaw at a salary of $6,000 per year.

Dr. J. W. S. McCullough, provincial medical health officer, returned yesterday from New York, where he has been investigating the latest methods for water filtration and other matters.

Mr. Frank Swayze has been appointed general manager of the Niagara, Welland and Lake Erie Electric Railway. Previous to accepting this position Mr. Swayze held a position with the Niagara. St. Catharines and Toronto Electric Railway.

Mr. George A. Guess has been appointed to the chair of Metallurgy at Toronto University. Mr. Guess is a graduate of Queen's University, class 1894. His metallurgical experience covers some years spent with the Greene Cavanea Cooper Company, the largest concentrating and smelting concern in Mexico. He was also with the Tennes-

see Copper Company, a company in the States doing pyritic smelting, and with the Cerro de Pasco Mining Company of Peru, one of the largest metallurgical establishments in South America. All the large copper refineries and smelters of the United States have been visited by him.

Recent changes amongst Canadian Pacific Railway Telegraph officials include the following: W. J. Camp to be assistant manager of telegraphs, with headquarters at Montreal. F. J. Mahon of St. John, N.B., to be superintendent of the eastern division, with headquarters at Montreal. J. Fletcher of Vancouver to be superintendent of traffic, Montreal. J. F. Richardson to be superintendent of the British Columbia division, with headquarters at Vancouver. Wm. Godsoe of Halifax to be superintendent of Atlantic division, with headquarters at St. John. John Tait of Winnipeg to be assistant to the general superintendent at Winnipeg. John McMillan of Calgary to be superintendent of the Manitoba division, with headquarters at Winnipeg. R. W. Young to be superintendent of the Saskatchewan division, with headquarters at Moose Jaw. Donald Coons to be superintendent of the Alberta division, with headquarters at Calgary. Mr. Dan H. Bowen of London, Ont., to be assistant superintendent of Ontario.

OBITUARY.

The death occurred suddenly of Mr. G. H. Massey, a director and chief engineer of the Reid-Newfoundland Company, at his late residence, 4224 Dorchester Street, Westmount, Montreal. The deceased gentleman had been ailing for the past year. His death was due to heart failure.

Mr. Massey was born in Tullow, County Dublin, Ireland, came to Canada in 1871. He was engineer-in-charge of the Chaudiere bridge, Ottawa, the Canadian Pacific Railway bridge at Lachine, and also the Sault Ste. Marie bridge. He had been connected with the Reid-Newfoundland Company for the past 14 years. The deceased is survived by his widow and eight children.

THE ENGINEERS' CLUB OF MONTREAL.

The Engineers' Club of Montreal was organized and incorporated in 1903 by a number of Montreal engineers. While the by-laws were made broad enough to admit not only engineers and architects, but also others engaged in engineering work, the majority of the directors must be engineers. This qualification was included with the intention of preserving control in the hands of the engineers. The functions of the club are of a social nature. The charter members were about forty in number; there is now, however, a full membership of four hundred and fifty and a considerable number on the waiting list.

In 1905 the club purchased the Dow property on Beaver Hall Square, midway between up and down town. This is an ideal location for a club of such a character. On the property was located a fine residence, which, with a few additions and changes, was made into very homelike and comfortable quarters. The president of the club is Mr. H. H. Vaughan, and the secretary, Mr. Smith.

ANNUAL MEETING, PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.

The Province of Quebec Association of Architects held their annual meeting in Quebec on January 13th. A dinner was held in the evening at Kent House, Montmorency Falls.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

A meeting of the Mining Section was held on Thursday, 11th instant, at 8.15 p.m., in the society's rooms, 413 Dorchester Street Montreal.

A paper by Mr. James R. Pearson, managing director of the Asbestos and Asbestic Co., Ltd., was read by the author.

CANADIAN INSTITUTE MEETING.

The members of the Canadian Institute held their usual meeting at the library, 198 College Street, Toronto, January 13th, at 8 p.m. Professor Angus, of the Department of Mechanical Engineering, University of Toronto, gave an illustrated lecture on "Types of Steam Engines," including rotary and reciprocating.

MEETING OF WESTERN CANADA RAILWAY CLUB.

The monthly meeting of the Western Canada Railway Club was held in the Royal Alexandra Hotel, on Monday evening, the 8th inst., at 8.30 o'clock. There was a very interesting discussion on the paper read at the previous meeting on "High Speed Steel."

At the close of the discussion there was a short entertainment and New Year's reunion.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION.

The 24th Annual Convention of the American Boiler Manufacturers' Association, together with its associate members, and the Supplymen's Association, will be held in New Orleans, La., March 12th, 13th, 14th and 15th, 1912, at which time some very important papers will be presented to the association and other important business of interest to all the boiler manufacturers in the United States and Canada, and supply houses dealing with the boiler and tank industry.

An extensive programme of entertainment has been arranged, and a large attendance of boiler manufacturers and supplymen from the United States and Canada are expected to be in attendance.

For further information relative to rates, hotel accommodation, etc., apply to F. B. Slocum, Secretary Supplymen's Association, of the American Boiler Manufacturers' Association, care of Continental Iron Works, Brooklyn, N.Y.

COMING MEETINGS.

THE ENGINEERS' CLUB OF TORONTO.—Wednesday, January 17th, 1912. 90 King Street West. Noonday address by Mr. Wyly Grier. Luncheon will be served promptly at 1.00 p.m., and members are requested to be in their seats before that time. R. B. Wolsey, Secretary.

THE CLEVELAND ENGINEERING SOCIETY.—January 23, 1912. Special Meeting, Chamber of Commerce Bldg., Cleveland, O. R. C. Beardsley, Hydraulic Engineer, will present an illustrated paper on "The Design and Construction of Dams," with special reference to recent failures. Secretary, F. W. Ballard.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Jan. 24. 25, 26, 1912, General meeting. 413 Dorchester St. West, Montreal. Prof. C. H. McLeod, Secretary.

CANADIAN FORESTRY ASSOCIATION.—February 7th and 8th, 1912. Forestry Convention Meetings held in the Railway Committee Room, Parliament Buildings, Ottawa. Secretary, Mr. James Lawler, Canadian Bldg., Ottawa.

CANADIAN LUMBERMEN'S ASSOCIATION.—February 6, 7 and 8, 1912. Annual Meeting to be held at the same time and place as the Canadian Forestry Association.

CANADIAN NATIONAL ASSOCIATION OF BUILDERS. — The Sixth Annual Convention will be held in Toronto, February 20, 1912.

ONTARIO GOOD ROADS ASSOCIATION.—Annual Convention to be held at Toronto, February 26, 27, 28. Secretary, J. E. Farewell, Whitby.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain, Acting Secretary; E. A. James, 57 Adelaide Street East, Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King's Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secretary, Mr. Heal, Moose Jaw

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Charles Kelly, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto. Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President. Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary. H Mortimer-Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, T. A Starkey, M.B., D.P.H., Montreal. Secretary, F. C. Douglas, M.D., D,P.H. 51 Park Avenue, Montreal.

CANADIAN RAILWAY CLUB.—President, H. H. Vaughan; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary, R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Alfred T. de Lury, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Medicine Hat, Alta., church	Jan. 20.	Dec. 28.	59
Ottawa, Ont., iron posts	Jan. 31.	Dec. 21.	68
Ottawa, Ont., breakwater, Rimouski, Que.	Jan. 16.	Jan. 11.	59
Ottawa, Ont., contracting machinery	Feb. 26.	Jan. 11.	59
Ottawa, Ont., jetty, Fraser River, B.C.	Jan. 19.	Jan. 11.	59
Ottawa, Ont., armory, Fernie, B.C.	Jan. 24.	Jan. 11.	59
Toronto, Ont., sewers	Jan. 16.	Jan. 11.	59
Toronto, Ont., supply of lead, 1912	Jan. 16.	Jan. 11.	59
Toronto, Ont., sewers	Jan. 16.	Dec. 28.	70
Toronto, Ont., main drainage works	Jan. 16.	Jan. 4.	70
Walkerton, Ont., bridge, Saugeen River	Jan. 23.	Jan. 4.	59
Winnipeg, Man., drawings for government buildings		Dec. 21.	68
Winnipeg, Man., motor generator set	Jan. 22.	Dec. 21.	59

TENDERS.

Arcola, Sask.—The date for receiving tenders for addition to school building at Arcola, Sask., has been extended to Thursday, February 1st, 1912. Plans and specifications may be secured at the office of Storey and Van Egmond, Architecbts, Regina, Sask. Jas. R. Donaldson, Secretary S.D. 637, Arcola.

Brantford, Ont.—Tenders will be received by the Board of Education until January 27th, 1912, for the erection of a two-story schoolhouse on Chestnut Ave. Building will be comprised of basement, 84 x 112 feet, ten rooms, brick with reinforced concrete floors, concrete foundation, steam heating, electric lighting, etc., two dynamos (1½ h.p. and 5 h.p.), modern plumbing. Secretary, A. K. Bunnell, Brantford.

Calgary, Alta.—Tenders will be received until February 10th, 1912, for the supply of material and construction of a steel bridge, 30 feet wide, in three spans of 150 feet each, on concrete substructure, across the Bow River, within the city limits. (See advertisement on another page of this issue).

Chatham, Ont.—Tenders will be received until January 20th, 1912, for all trades in erection of a reinforced concrete brick and steel, fireproof building for the Chatham Gas and Electric Light Co., Ltd. Drawings, specifications, etc., can be seen at the offie of the architects, Jas. L. Wilson & Son, Chatham, Ontario.

Chesley, Ont.—Tenders will be received by the Department of Public Works, Ottawa, until January 31st, 1912, for the erection of a public building. Plans, specifications, etc., may be obtained at the office of Mr. Thos. A. Hastings, Clerk of Works, Postal Station F, Yonge St, Toronto; at the post-office, Chesley, Ont.; at the office of Foster & Clark, architects, Owen Sound, Ont., and at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Grandview, Man.—Wanted—For the Rural Municipality of Grand View, six (6) wheel scrapers, size two and one-half (2½). Tenders to be in by February 1st, 1912. Wm. Dickie, secretary-treasurer, Grandview, Man.

Halifax, N.S.—Tenders will be received until January 17th, 1912, for the installation of a new heating boiler in the city hall. Specifications, etc., may be obtained at the City Engineer's office. J. J. Hopewell, Clerk of Works.

Montreal, Que.—The city is contemplating an addition to the sewage farm at Back River, to cost $50,000. City Engineer, G. Janin.

Ottawa, Ont.—Tenders will be received until February 5th, 1912, for the erection of a wooden lighthouse tower at Lions Head, Lake Huron, Ont. Plans, etc., at the Department of Marine & Fisheries, Ottawa; at the post offices, at Lions Head, Owen Sound, Collingwood, and Wiarton.

Ottawa, Ont.—Tenders for the improvement of the public wharf at Petewawa, North Renfrew County, Ont., will be received at the Department of Public Works until January 31st, 1912. Plans, etc., obtained at the offices of J. G. Sing, Esq., District Engineer, Confederation Life Bldg., Toronto; on application to the Postmaster at Petewawa, Ont., and at the Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until January 29th, 1912, for the supply of 650,000 tons of Bituminous Coal for the Intercolonial Railway, and 13,000 tons of Bituminous Coal for the Prince Edward Island Railway. Lois Lavoie, Purchasing Agent, Ottawa.

Regina, Sask.—Tenders marked "Tenders for Telephone Supplies," will be received until noon, Saturday, January 20th, 1912, at the office of D. C. McNab, Acting Deputy Minister, Department of Railways and Telephones, Regina.

Saskatoon, Sask.—Tenders will be received until February 16th, 1912, for the construction of approximately 125,750 square yards of pavements. Geo. T. Clark, City Engineer, Saskatoon. (Adv. in the Can. Eng.)

Saskatoon, Sask.—Tenders will be received until February 16th, 1912, for the construction of approximately 621,200 square feet of concrete walk and 100,950 lineal feet of curbing. City Commissioner, Geo. T. Clark, City Engineer, Saskatoon. (Adv. in the Can. Eng.)

Toronto, Ont.—Tenders will be received until January 31st, 1912, for the construction of concrete abutments and a steel bridge, 100-ft. clear span, and also for a reinforced concrete truss bridge, 50-ft. clear span, over the Burnt River, in the village of Haliburton, municipality of Dysart. Frank Barber, Civil Engineer.

Vancouver, B.C.—Tenders will be received by the undersigned up till January 27th, 1912, for the year's supply of the following articles: Cast-iron castings, cement, sand and gravel, sewer pipe and fittings, pig lead, lead pipe, galvanized pipe fittings, brass fittings, lubricating oils and greases, hardware, engineer's supplies. Specifications, blank tender forms and all particulars may be obtained from my office. James Stuart, City Purchasing Agent.

Victoria, B.C.—Tenders will be received until the 31st day of January, 1912, for the erection and completion of a large one-room frame school house at Johnston Road, in the Delta Electoral District, B.C.. Plans, etc., may be seen at the offices of the Rev. T. H. Wright, Secretary of the School Board, Cloverdale, B.C.; the Government Agent, New Westminster; and the office of J. E. Griffith, Public Works Engineer, Department of Public Works, Victoria, B.C.

Winnipeg, Man.—Tenders will be received until February 1st, 1912, for the manufacture and delivery f.o.b. Winnipeg of an electric vehicle. Further information may be obtained at the office of the General Manager City Light and Power Department, 54 King Street. M. Peterson, Secretary Board of Control Office, Winnipeg.

CONTRACTS AWARDED.

Lethbridge, Alta.—A new $20,000 hotel will be erected at Kipp, by Mr. J. V. Harrington, Kalispell, Montana.

Ottawa, Ont.—The contract for the construction of an extension to the protection pier at Gimli, Selkirk Co., Man., has been awarded to Messrs. Buchanan & Fraser, of Winnipeg, at $9,910.

Vancouver, B.C.—The British North America Construction Company, Bank of Ottawa Bldg., will begin shortly the construction work on a wharf, Carrall Street, for the Union S. S. Co., Carrall St. Cost, $70,000.

Vancouver, B.C.—Instructions have been given by the Grand Trunk Pacific to Foley, Welch & Stewart, that the main line from Tete Jaune Cache to Fort George must be finished by next fall. In consequence, sub-contracts have been awarded as follows:—H. E. Carleton & Company, Edmonton, 25 miles west from Cache; Messrs. Burns, Jordan & Company, of Spokane, 50 miles; Messrs. Sims Brothers & Keary, of St. Paul, 75 miles. There is still unlet to sub-contractors a gap of thirty miles.

Vancouver, B.C.—Messrs. Griffin & Wilson, Spokane, have received the sub-contract for the construction of the remaining thirty-five miles on the main line, from Tete Jaune Cache to Fort George, of the Grand Trunk Pacific. General contractors, Messrs. Foley, Welch & Stewart.

Vancouver, B.C.—The Portland Cement Construction Co. has let the contract for the immediate construction of a huge cement plant on Tod Inlet, Vancouver Island, to the McAlpine, Robertson Construction Company, Metropolitan Bldg. This concern is a branch of Robert McAlpine Sons, Glasgow and London. It is understood that the proposed plant will approximate very closely to $1,000,000.

Victoria, B.C.—The contract for the new plant of the Pacific Coast Cement Company on Saanich Arm has been let to the McAlpine, Robertson Construction Company, Vancouver, and work will be commenced immediately.

Winnipeg, Man.—The contract for the superstructure of the twelve-story office building for the Union Trust Company, to be erected on the northeast corner of Main and Lombard Streets, has been let to the George A. Fuller Company of Montreal, Chicago and Winnipeg.

Winnipeg, Man.—The contract for the superstructure of the new Osborne street bridge has been awarded to the Manitoba Bridge & Iron Works. Total cost of work about $116,461, will include cost of tearing down the present superstructure and re-erecting it over the Assiniboine River at Arlington Street. The whole work is to be completed within six months from the date of signing of contract. The Algoma Steel Bridge Company was the lowest tenderer, but as it asked for nine months to build the bridge, the tender was not accepted.

RAILWAYS—STEAM AND ELECTRIC.

Province of Alberta.—A report states that the Canadian Pacific have assumed complete control of the Alberta Central Railway, and will be responsible for all debts of that company. Work will be pushed ahead rapidly by the C.P.R. in the spring in order to have the line to the Brazeau coal fields finished next year, and it is also understood 100 miles of the line east of Red Deer will be built in 1913.

Province of British Columbia.—It is officially stated that the Canadian Pacific Railway will shortly operate its locomotives on its mountain division between Field and Kamloops B.C., by crude oil.

Calgary, Alta.—It is estimated that the yearly receipts from the Street Railway operations will amount to $391,000.00, of which nearly $120,000.00 will be profit.

Fredericton, N.B.—Sir Thomas Tait has acquired the control of the Fredericton and Grand Lake Coal and Railway Company. The plans for the development of the Grand Lake coal areas include the construction of the railway from Gibson to Minto, a distance of 30 miles, for the delivery of 10,000 tons of coal annually, which the C.P.R. will take. The construction work on the railway will be commenced early in the spring. At this session of the Dominion Parliament the Dominion subsidy for the road will be re-voted.

Montreal, P.Q.—Details of the proposed terminals of the Canadian Northern Railway include the following: A double tracked tunnel 3.3 miles in length from a point half a mile west of the C.P.R.'s Outremont yards to Lagauchetiere Street. An underground station on the Dorchester street site of the Joseph Estate. Elevated tracks from the tunnel mouth to the level of the present Brennan Street tracks. Elevated freight sheds between William and Wellington Streets, and Dalhousie and Nazareth Streets. Depth of the tunnel from 700 to 40 feet; elevation of the tracks from 16 to 20 feet. River front communication with the Moreau Street station and a spur line from the latter point to the proposed Dorchester Street terminal.

Ottawa, Ont.—The original plans of the Hudson Bay railway have been adopted, viz., from Pas Mission to Port Nelson. The contract was awarded to J. D. McArthur by the late government. It is understood that he will begin construction work at an early date.

Province of Ontario.—Conservtive members of the Ontario Legislature asked Premier Whitney yesterday to assist the Bruce Mines and Algoma Central Railway to extend its lines farther north.

Prince Rupert, B.C.—The Railway Commission have ordered the Grand Trunk Pacific to re-open Cameron Creek in a way to make it again navigable.

Quebec, P.Q. — The Ottawa, Abitibi and Hudson Bay Railway Company will apply to the Quebec Legislature for an Act authorizing it to construct and operate a line of railway within the Province of Quebec from a point near the City of Hull, Quebec, in a northwesterly direction, through the southwesterly part of the County of Wright; thence in a northwesterly direction through the County of Pontiac, via the Valley of the Coulonge River to Grand Lake Victoria; thence in a northwesterly direction to a point on the National Transcontinental Railway at or near Lake Mattagami; thence in a northerly by northwesterly direction to a point near James Bay.

Victoria, B.C.—The Victoria Harbor Railway Company will apply for an extension of time.

Vancouver, B.C.—At a largely attended mass meeting held at this city recently, a resolution was passed unanimously endorsing the project for a railway from Vancouver to the Peace River country. It was also decided to send a delegation to interview Provincial Premier McBride on the subject.

Vancouver, B.C.—The Great Northern Railway Company has been asking for bids for the dredging of the slips and approaches to its proposed piers on its 1,800 feet of Burrard Inlet waterfront in this city. The management was unsuccessful in its efforts to rent the Dominion Government dredge Mastodon for the purpose of doing this work and the contract may be awarded to a United States concern as there is only one privately-owned dredge in British Columbia waters, and it is declared to be of insufficient capacity to perform the improvement. It is estimated that about 150,000 cubic yards of sand, hardpan and rock will have to be excavated.

Winnipeg, Man.—Seven new locomotives have been delivered to the Grand Trunk Pacific within the past few days. The measurements are—length, 73 feet; weight, 200 tons; track power, 31,600 pounds; water capacity, 8,000 gallons.

York County, Ont.—Plans are developing for the extension of the Toronto Suburban Railway from the town of Weston to the town of Woodbridge. This distance is eight miles.

LIGHT, HEAT AND POWER.

Fredericton, N.B.—Repairs to the municipal power plant are a necessity, the pressing requirements are fifty new lamps at $24.00 each and a new armateur at $850.00. Owing to considerable trouble of late in the street lighting the Fredericton Gas Light Company are preparing a proposition to light the highways by gas.

Galt, Ont.—A committee has been appointed to look after the improvements in the lighting system of the library. Mr. Chas. Turnbull is a member of the Board.

Kingston, Ont.—On the advice of the Hon. Adam Beck the municipality will supply the Grand Trunk Railway with 500 electrical horsepower for use in their granite quarry. This supply is temporary.

For medium traffic and residential streets.

Dolarway Pavement

For permanent state highways, park roads, boulevards, etc.

IT IS PERMANENT BECAUSE IT IS CONCRETE.

What is Dolarway Pavement?

FIVE to six inches of Portland Cement Concrete provided with the necessary expansion joints. The surface is then treated with our adhesive Dolarway Bitumen and with coarse sand or fine gravel or screenings. This seals the concrete, prevents cracking and chipping, and produces a wearing surface which is clean, noiseless, resilient and similar in appearance to other forms of bituminous pavement.

What Does It Cost?

You can figure out what the concrete will cost per square yard in your vicinity. Add to this from 25 cents to 35 cents per square yard which represents the cost of the bitumen sand and labor, and the small royalty charged by our Company.

Great Economy Possible.

Sealing the surface of the concrete by our method makes it possible, for the first time, to construct a pavement or highway having a concrete base and a noiseless bituminated wearing surface at from 50 cents to $1.00 per square yard less than the cost of any other permanent pavement.

Low Cost of Maintenance

The Dolarway Pavement can be resurfaced when necessary at a price of from ten to twenty cents per square yard, thus making it as good as new and prolonging its life indefinitely.

Medium Traffic and Residential Streets.

Permanent, noiseless and dustless. Not affected by motor traffic. Ideal for the smaller cities, as no expensive machinery is required.

For Good Roads.

Wherever there is gravel or stone (hard or soft), you can build Dolarway Pavement cheaper than any other permanent roadway.

Notice to Contractors.

Correspondence solicited from responsible contractors to represent Dolarway Pavement for unallotted territory.

DOLARWAY PAVING COMPANY

95 Liberty Street,
NEW YORK CITY.

510 Title and Trust Building,
CHICAGO.

One of the methods of applying and spreading Dolarway Bitumen on Concrete Base.

Finished Dolarway Pavement.

Lakefield, Ont.—The Hydro-Electric by-law having carried, the town proposes to spend $8,000 on a distributing plant and sub-station. Mr. E. A. Tanner, reeve.

Quebec, P.Q.—The Saint Maurice Hydraulic Company will apply to the Legislature of Quebec for an act to construct storage and regulating dams on the Saint Maurice River and its tributaries.

Vancouver, B.C.—An addition unit of 10,500 h.p. is now running at the plant of the B.C. Electric Railway Company. The output of the plant at present is 43,500 h.p. To accommodate the new unit a stone and concrete fireproof extension of 60 feet was made to the power house on the shore of the North Arm. The unit represents an outlay of approximately $250,000.

SEWAGE AND WATER.

Calgary, Alta.—The report of the city engineer, Mr. Childs, calls for an expenditure of $405,000.00. He recommends a filtration system:

Costing	$200,000
New intake costing	90,000
Enlargement of reservoir	85,000
Sedimentation tanks	30,000

Edmonton, Alta.—The city commissioners have decided to construct two new intakes and a well on the river bank; also to abandon the present intake. The city engineer, Mr. A. J. Latornell, has been instructed to prepare plans, etc. Ice has seriously damaged the present intake.

Galt, Ont.—Hydro-electric energy will be used to operate the pumps at the municipal waterworks. P. W. Sothmann, of the Hydro-Electric Commission, has suggested the use of a 250 K.V.A. synchronous motor running at 2,200 volts pressure as the most satisfactory method of taking care of the power factor.

Galt, Ont.—The town council has between fifty and sixty men working, mostly on sewers, at the present time and it is likely that this number will shortly be increased to one hundred.

Guelph, Ont.—The by-law providing for the election of Sewerage and Public Works Commissioners was given its third reading and passed by the council.

Ingersoll, Ont.—The late council passed a by-law to purchase the waterworks for the sum of $125,000.00.

Montreal, P.Q.—The bursting of a water main on St. Nicholas Street caused serious loss to several tenants of the Coristine building. The damages are estimated at about $2,000.

New Westminster, B.C.—The Municipal Construction Company have presented an account to the council for $3,000.00 for repairing 700 leaks in the water mains leading from Lake Coquitlam. This firm has the contract for laying the main. The pipe was purchased by the city council in 1909, and the contract let in 1910. The fault was that the collars used were of a defective design and that they were in most cases too large. The contractors had to insert a flattened wire before they could caulk the joints. 150 leaks are due to loose rivets. A strict investigation will be held.

Toronto, Ont.—The Works Committee have recommended the municipal council that a sewer be reconstructed on Sorauren Ave. The cost of the work will be about $44,077 to be assessed against the property benefited to the extent of $11,148, and against the city to the extent of $32,929.

Toronto, Ont.—A new pumping engine with a capacity of 15,000,000 gallons a day, will likely be included in the estimates of the City Engineer.

Victoria, B.C.—The municipal council have passed a resolution in favor of increasing the sewage handling facilities.

DREDGING MACHINERY.

One of our subscribers would like to be put in touch with firms who make dredges suitable for drainage work of from five hundred thousand to one million cubic yards. The widths would vary from forty to one hundred feet. He says a dipper dredge would hardly be suitable, owing to the distance the earth has to be moved to clear the banks of the cut. Any information on this subject will be appreciated by the Service Bureau, Canadian Engineer.

BUILDING.

Baden, Ont.—The Baden Board of Trade are endeavoring to secure a Carnegie library. Mr. Gideon Bechtel is chairman of the Board. (Baden is near Galt.)

Brantford, Ont.—The Cockshutt Plow Company have purchased the plant and buildings of the Brantford Carriage Company. Large additions to the buildings are among the plans of the Cockshutt Company.

Fort William, Ont.—A new hotel for the Grand Trunk Pacific, to cost $750,000.00, is among the plans of building operations for 1913.

Fort William, Ont.—Work in connection with the erection of the addition to the G.T.P. elevator has commenced. The John S. Metcalf Contracting Company, Montreal, secured the contract. The sub contracts have been awarded to an Omaha, Nebraska, firm.

Frank, Alta.—The Keystone Portland Cement Company, capitalized at $600,000.00, will begin building operations at an early date. The plans call for the employment of 100 men and a daily output of 1,000 barrels. The president is Mr. A. Muller, of Frank and Paris, general manager of the Canadian Coal Consolidated Co. of Frank.

Galt, Ont.—The Katie Foundry will erect new premises in Galt. A site has been secured on the river front. The main building will be of brick and concrete, seventy feet square and an annex, 70 × 120 feet, will be built along the full length of the building. This will be a two storey brick structure. The latest appliances, including two five ton electric cranes, will be installed and modern methods of handling and storing the raw materials will be used. Mr. J. R. Ferguson, of Galt, is president of this foundry.

Province of Ontario.—The estimates of the Dominion Government include the erection of the following public buildings:—

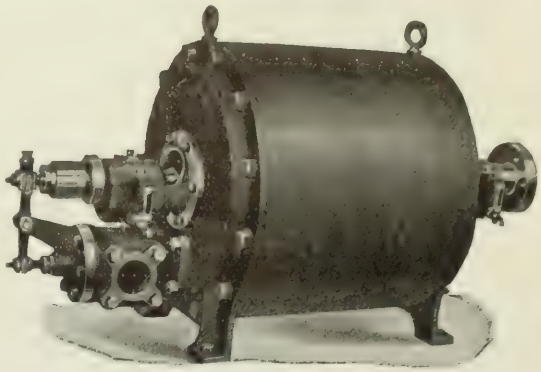
Athens—Public building	$18,000
Aurora—Public building	6,000
Aylmer—Public building	15,000
Barrie—Public building, improvements of grounds	1,000
Bracebridge—Public building	18,000
Campbellford—Public building	15,000
Dominion—Public building, renewals, repairs, improvements, etc.	20,000
Dresden—Public building	12,000
Dundas—Public building	31,000
Durham—Public building	10,000
Elora—Public building	8,000
Elmira—Public building	5,000
Essex—Post-office	20,000
Fergus—Public building	8,000
Fort Frances—Public building	15,000
Fort William—Public building enlargement	11,000
Gananoque—Post-office	25,000
Goderich—Public building, addition	5,000
Hamilton—Examining warehouse, additions and improvements	10,000
Hanover—Public building	10,000
Harriston—Public building	19,000
Kemptville—Public building	10,000
Kingston—Post-office, addition to building and alterations	50,000
Kingston—Royal Military College, additional dormitory accommodation for cadets	75,000
Kingston—Customs House renewals and repairs to building	1,300
Kingsville—Public building	15,000
Listowel—Public building	21,000
Midland—Public building	25,000
Milverton—Public building	10,000
Mitchell—Public building	15,000
Mount Forest—Public building	14,000
Niagara Falls—Armory	10,000
Niagara Falls—Public building, fittings, improvements, etc.	6,000
Oshawa—Public building, addition to	9,000
Ottawa—Printing Bureau, raise chimney, etc	6,000
Ottawa—Departmental buildings, fittings, etc	25,000
Ottawa—Departmental buildings, improvements in lavatories, plumbing, etc.	12,000
Ottawa—Examining warehouse	300,000

Kerr Turbo-Generators

FOR SMALL LIGHTING PLANTS

The Kerr Turbine is peculiarly suited to generator driving and our sets are made in suitable sizes to fill all requirements up to 500 kw. alternating and 350 kw. direct current. The operation is economical throughout a wide range of initial steam pressures, the steam economy is improved by superheat, and any exhaust conditions are permissible. When operating non-condensing, the steam consumption compares favorably with that of a high speed engine of the same capacity, while in condensing plants the economy at full loads equals that of the best compound engine and at fractional loads is much better.

A Kerr Turbo-Generator for lighting or small power or both is extremely profitable in any plant having power boilers, since the freedom of the turbine exhaust from oil makes reuse of the exhaust inexpensive and safe for boiler feeding or any other purpose where clean low pressure steam is desirable. See Bulletin No. 22.



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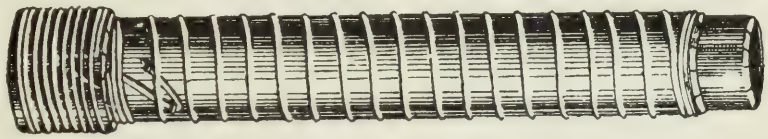
WOODEN WATER PIPE



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For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

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PACIFIC COAST PIPE CO.

LIMITED

Factory: 1551 Granville Street, VANCOUVER, B.C.

P.O. Box 563. Full Particulars and Estimates Furnished.

Ottawa—Fuel testing, enlargement of concentrating laboratory	10,000
Ottawa—Old Museum building, Sussex Street, alterations	25,000
Ottawa—Parliament Buildings, improvements	10,000
Ottawa—Departmental Buildings west block elevator	7,500
Ottawa—Parliament grounds driveway pavement	13,000
Ottawa—Parliament grounds, additional water service	2,000
Paris—Public building improvements	5,000
Peterboro'—Post-office building, addition to	3,500
Port Arthur—Armory	49,000
Port Arthur—Public building for Customs and Inland Revenue, etc.	15,000
Port Perry—Public building	25,000
Renfrew—Public building improvements	3,000
Seaforth—Public building	25,000
St. Catharines—Public building improvements	2,500
Sudbury—Public building	20,000
Tilbury—Public building	20,000
Tillsonburg—Public building	20,000

Todd Inlet, B.C. — The Portland Cement Contraction Company has commenced operations on the erection of a million-dollar plant at Todd Inlet, Vancouver Island.

Toronto, Ont.—The City Engineer, Mr. C. H. Rust, has been instructed to find some one willing to remove a large wooden bridge on Toronto Island. The party will have the material for his trouble. The bridge is entirely wood construction and in a fair state of preservation.

Toronto, Ont.—The $600,000 appropriation passed by the Board of Control for the supplementary building estimates include:

New Schools.

Clinton Street	$ 75,000
St. Clair Avenue	55,000
Dovercourt district	60,000
Western Avenue district	60,000
Morley Avenue	115,000
Total	$365,000

Enlargements.

Malvern High School	$ 60,000
Brock Avenue or Kent	75,000
Alterations	55,000
Purchase of sites	45,000

Vancouver, B.C.—A report states that a ten-story steel and concrete office building will be erected for Messrs. Henry Birk & Sons, of Montreal, P.Q. The total investment will be approximately $1,000,000, of which $450,000 is for land value.

Victoria, B.C.—The municipal board of health have impressed the newly formed council with the necessity of erecting an isolation hospital at an early date.

Woodstock, Ont.—The mayor recommended the council to prepare a measure for the erection of a new city hall.

ROADS AND PAVEMENTS.

Aurora, Ont.—Sir William Mulock has made an offer to the town of Aurora to contribute $3,000 towards the expense of making Yonge Street in the town limits a first-class roadway, or as good as that planned by the "good roads commission." Aurora is not in the good roads zone.

Galt, Ont.—The Board of Works has been instructed to call for tenders for a new steam road roller.

Province of Quebec.—The provincial Minister of Agriculture announces that $300,000.00 will be spent during 1912 for road improvements within the province.

Welland, Ont.—The Welland Town Council held a meeting in the Town Hall on Friday evening, the 12th inst., when they instructed the town engineer to prepare at once plans for this year's pavement, said plans to be ready in four weeks, when tenders would be called for, to allow the work being commenced not later than 1st of May. Pavements are to be laid on East Main Street from Grand Trunk Station to Canal Bridge; on South Main Street from Canal Bridge to Michigan Central Station; and on West Main Street from Canal Bridge to Niagara, St. Catharines and Toronto Railway Station. Tenders will be called for three or four different kinds of pavements, and will cover an area of 40,500 square yards. It is further expected that the residents on Hellems Avenue, Division Street, Merritt Street, part of Shotwell and part of Elgin Street will petition at an early date for pavements.

BRIDGES, DOCKS, ETC.

Province of Ontario. — The estimates of the Dominion Government include the following dock expenses for this province. The appropriation for rivers and harbors for Ontario aggregates $1,122,275, of which $547,175 is to be revoted. The details are as follows:—

Brockville—Extension of Tunnel Bay dock	$ 9,000
Cobourg—To repair and reconstruct superstructure on east pier at north end	10,000
Detroit River—Protection of east bank in the Township of Malden, to complete	2,500
French River, Lake Nipissing—Regulating works at outlets	11,200
Goderich—Harbor improvements	150,000
Gravenhurst—Wharf on Lake Muskoka	9,000
Haileybury—Harbor improvements	10,500
Hamilton—Harbor improvements	54,000
Harbors, rivers and bridges, general repairs and improvements	50,000
Huntsville—Wharf extension	1,750
Kincardine—Extension to pier and dredgnig	25,000
Kincardine—Repairs to pier	1,000
Kingston—Royal Military College, renewing wharfs	16,000
Kingston—Harbor improvements	50,000
Leamington—Repairs to wharf	1,000
Lakeport—Reconstruction of wharf	1,600
Lion's Head—Dock extension and harbor improvements	6,000
Meaford—Closing of eastern entrance and removal of L of inner check water	34,000
Montreal River—Removal of boulders in flat rapids	3,500
Montreal River—Improvements above Latchford	35,000
New Liskeard—Harbor improvements	18,000
North Bay—Breakwater	16,000
Owen Sound—Harbor improvements	36,200
Owen Sound—Harbor improvements to repair sheet piling along west side of harbor	3,500
Peterboro—Wharf	13,500
Pembroke—Repairs to wharf and approach	2,500
Port Bruce—Extension of west pier and repairs to east and west piers	1,800
Port Burwell—Improvements to harbor works	50,000
Port Colborne—Urgent repairs to east breakwater	17,000
Port Hope—Repairs to and improvements to piers	9,000
Port Stanley—Harbor improvements	100,000
Providence Bay, Manitoulin Island—Extension wharf	16,500
River St. Lawrence—Improvement of Canadian channel between Kingston and Brockville	60,000
River Thames—Removal of obstructions, etc.	4,000
Rousseau—Wharf repairs	800
Saugeen River—Repairs to north and south piers	1,000
Sault Ste. Marie—Improvements to old Plummer Wharf and approach	32,000
Sault Ste. Marie—Wharf addition to return on west side	8,000
Sturgeons Falls—Completion of dock	1,000
Southampton—Harbor improvements	1,750
Toronto—Harbor improvements	195,000
Windsor—Landing dock and improvements	50,000

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending January 1st, 1912:—

A Liverpool firm who are large buyers of dried and pickled fish are open to hear from Canadian shippers.

A Welsh firm interested in a process for utilizing sawdust are desirous of getting into touch with Canadian lumber manufacturers.

Seven Great Money-Saving Packings

Engineers and machinists throughout the Dominion are saving thousands of dollars in *time alone* by using Goodyear Packings—*short cuts* to *RESULTS.*

Installed quickest and most easily. *Outlast* all others. Recognized by all who *know packings*, as the highest standard of excellence. Use one of these great

GOODYEAR Packings

Magnet Sheet Packing

Meets *every requirement*—Boiler Room or Machine Shop. Made of special compound that *resists heat*, hence the *only* packing thoroughly adapted for high pressure uses. Makes tight joint under air or hot or cold water pressure, *Unaffected* by oil, liquor, ammonia, or alkali. Retains elasticity.

Magnet Gasket Tubing

For high pressure. Like Magnet Sheet Packing this tubing is unaffected by heat, makes tight joint, can't *blow out.* Cut any length to fit any size manhole, hand-hole, plate or pipe flange. Put up in convenient boxes with rubber core and tape.

Round Duck Packing

Fine quality cotton duck with round core. Used like Hydraulic Packing, *only for lower pressure.*

Hydraulic Packing

Best Packing for pump cylinders, inside-packed plungers pumping hot or cold water, and hydraulic elevators. Unexcelled for boiling water and high pressure hydraulic work.

Cloth Insertion Packing

For cold and warm water pipes. Unexcelled in pliability, smoothness of finish and strength of cloth insertion. Made of heavier fabric than any other similar packing on the market.

Square Duck Packing

Good quality cotton duck and friction to stand cold water. Cut accurately into squares.

Square Duck With Rubber Back

Specially adapted for elevator use. Made of superior cotton duck, gum back Makes packing tight, practically no friction. Gives many times service of other packings of same nature.

Valves

Unaffected by oil. Used in hundreds of industrial plants. Specially made to meet specific conditions.

Goodyear Packing, Belting, Hose and other rubber sundries enable you to capitalize the brains and experience of the world's greatest rubber goods experts—the knowledge and skill that underlies our reputation as well as that of the Goodyear Tire & Rubber Company, Akron, Ohio, the best known plant of its kind in the United States.

Get in touch with us at once

The Goodyear Tire & Rubber Company of Canada, Limited

General Offices—Toronto **Factory—Bowmanville, Ont.**

Write Our Nearest Branch

BRANCHES: Montreal — Winnipeg — St. John, N.B. — Vancouver — Calgary — Victoria, B.C., 855 Fort Street—Regina, Sask., 2317-2318 South Railway Street — Hamilton, Ont., 127 King Street West. 9

A London firm of iron, steel and metal merchants desire to appoint an agent at Calgary.

A London firm manufacturing an extract of coffee desire to open up business in Western Canada.

A Staffordshire manufacturer of fancy earthenware is desirous of appointing Canadian representatives.

A London produce importer would like to hear from Canadian buyers of tomato puree.

A German commission house wish to get into touch with some good furniture dealers in Canada open to handle Russian made bentwood furniture manufactured in the Austrian style.

A Montreal firm of lubricating oil manufacturers make inquiry for the names of United Kingdom refiners of rape oil.

A Toronto firm desire to get into touch with a United Kingdom firm able to supply large regular shipments of castor oil.

A Winnipeg firm desire to get into communication with manufacturers of twist drill bits, such as are used by woodworkers, blacksmiths, etc.

A real estate agent stated to have been established for many years in British Columbia wishes to represent a first-class fire insurance company.

A Toronto firm desire to get into touch with a United Kingdom manufacturer of gasoline road rollers.

A Canadian firm desire to take up the representation of a United Kingdom manufacturer of whiting.

A firm at Toronto are desirous of obtaining the representation of English china clay merchants.

A firm in the Province of Ontario are contemplating the export of maple and basswood last blocks, and would like to hear from United Kingdom users or manufacturers of shoe lasts open to purchase supplies.

A Toronto firm wish to secure the representation of United Kingdom chemical manufacturers, and have an immediate demand for large quantities of sulphur and borax.

A Montreal correspondent is open to take up United Kingdom agencies for inks, glues, dye-stuffs, and other lines excepting dry goods.

Inquiry is made by a Toronto firm for the names of United Kingdom manufacturers of fire engines.

A Canadian firm are open to import Portland cement, and would like to hear from United Kingdom firms open to do Canadian trade.

From the branch for City Trade Inquiries, 73 Basinghall Street, S.E.:—

A London manufacturing firm seeks supplies of special wood handles as used in the production of baby carriages, and would be glad to receive quotations from Canadian manufacturers.

A Yorkshire company manufacturing specialties in wood stains and preservatives, and also paints and enamels, ask to be placed in touch with a first-class Canadian firm who would be prepared to act as their representative.

CURRENT NEWS.

Berlin, Ont.—A society taking the name of the Great Waterways Union of Canada has been organized in this municipality. The object is for the purpose of developing the inland waterways of Canada, and the securing of navigation for ocean vessels on the Great Lakes via St. Lawrence and Welland canals route. The Mayors and Presidents of the Boards of Trade of the towns and cities of Canada will constitute the general committee, and will be invited to signify their intention of acceptance.

Calgary, Alta.—Mayor Mitchell is at present investigating the fire alarm system of some eastern Canadian cities. It is highly probable that a system costing $35,000 to $40,000 will be installed at an early date.

Sydney, C.B., N.S.—The output figures of the Dominion Iron & Steel Company's plant for December are as follows:

Coke	47,121 tons
Pig Iron	30,062 tons
Steel Ingots lb.	30,241 tons
Blooms	24,551 tons
Rails	5,014 tons
Rods	7,509 tons
Sulphate Ammonia	445 tons

BUSINESS.

Hamilton, Ont.—Fire considerably damaged the plant of the Dominion Vinegar Company. The loss is estimated at $20,000.00.

Regina, Alta.—$180,000.00 was the estimated loss to the McCarthy Supply Company when their departmental store was badly damaged by fire.

Moosejaw, Sask.—The Moosejaw Machine Works are now under the control of Saskatchewan Bridge and Iron Company.

Indian Head, Sask.—Damage amounting to $20,000 was caused by fire to the experimental farm buildings at this point.

PERSONAL.

Mr. E. Cousins has been appointed to the position of engineer of the Civic Harbor Commission of Toronto, Ont.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

ORDER NO. 15754.

Whereas many general complaints and petitions have been made to the Board against the existing freight rates charged by the railway companies operating in Canada west of Lake Superior, and the Board had been delaying the consideration thereof until the final determination of the Regina Rate Case;

And whereas the Supreme Court of Canada, on the 6th day of December, ultimo, dismissed the appeal of the Canadian Pacific and Canadian Northern Railway Companies from the Order of the Board No. 12520, dated the 10th day of December, 1910, in the matter of the application of the city of Regina (above referred to), requiring the discrimination in favor of points in the Province of Manitoba, and against points in the Provinces of Saskatchewan and Alberta, to be removed by reducing the class freight rates from Port Arthur and Fort William, and points east thereof, to the said points in Saskatchewan and Alberta, and the said dismissal having left the Board free to undertake a wider investigation;

And whereas the tolls of the railway companies operating in the Province of British Columbia are already the subject of enquiry by the Board, upon the complaints of the Vancouver Board of Trade and the United Farmers of Alberta;

And whereas the Board is empowered by the Act, upon its own motion, to hear and determine any matter or thing which, under the Act, it might enquire into, hear and determine upon application or complaint;

Therefore it is declared to be advisable that:

(1) A general enquiry be at once undertaken by the Board into all freight tolls in effect in the Provinces of Manitoba, Saskatchewan and Alberta, and in the Province of Ontario, west of and including Port Arthur, with the view that, in the event of its being determined that the said tolls, or any of them, are excessive, the same shall be reduced as the Board may determine.

(2) A sitting of the Board will be held at the city of Ottawa on Tuesday, the 13th day of February, 1912, at ten a.m., to consider the procedure upon the said enquiry and give directions with reference thereto.

NOTE:—The Board is applying to the Minister of Justice to appoint counsel to represent the public upon the said enquiry.

15696—December 27—Authorizing C.P.R. to open for carriage of traffic its (portion of) Weyburn-Lethbridge Line from mileage 52.2 to mileage 75.85, a distance of 23.65 miles, Ogama to Viceroy.

15697—December 28—Authorizing Esquimalt & Nanaimo Railway to use and operate bridges at mileages 14.0, 54.4, 131.7 and 132.3.

15698—December 26—Relieving C.P.R. from further protection at crossing mileage 45.1 from Place Viger Station.

15699—December 29—Approving revised location of C.P.R. Swift Current to Brooks Branch at mileage 0 to 35.32, Saskatchewan.

15700—December 28—Authorizing C.P.R. to construct its Wilkie Northwesterly Branch across highway at mileage 7.64, Saskatchewan.

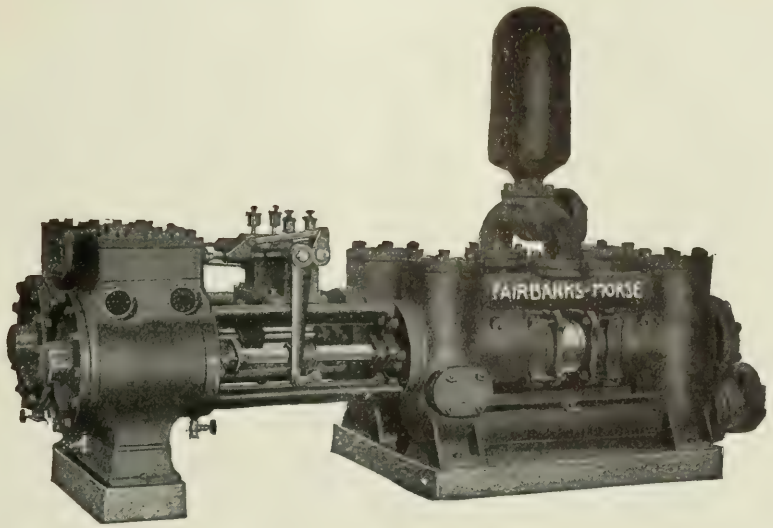
15701-02—December 29—Authorizing C. N. O. Ry. to cross three highways in Twp. of Trafalgar, County of Halton, Ontario, and highway in Twp. of Nelson, County of Halton, Ontario.

15703—December 27—Authorizing C.N.R. to construct spur in city of Saskatoon, Sask., north of Seventeenth Street.

15704—December 28—Authorizing G.T.R. to operate its trains through junction at Alford Jct., Ont., without stopping.

15705—December 28—Authorizing G.T.R. to construct spur for National Brick Co., Ltd., at St. Constant, Que.

15706—December 28—Approving certain changes and alteration in G.T.P. Ry.'s revised location in District of North Alberta, Alta.



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15707—December 28—Authorizing C.N.O. Ry. to cross seven highways in Twps. of Nelson and Trafalgar, Counties of Peel and Halton, Ont.

15708—December 28—Approving location of C.P.R. Wilkie to Anglia Branch at mileage 24.90 to mileage 40.66 and to cross and divert fourteen highways, mileage 25.55 to 40.66, Saskatchewan.

15709—December 29—Authorizing C.P.R. to construct two spur lines for Imperial Oil Co., Ltd., near Alexander Avenue, Winnipeg, Man.

15710—December 29—Authorizing C.N.O. Ry. to cross three highways in Twp. of Nelson, County of Halton, Ont.

15711—December 30—Authorizing C.P.R. to reconstruct bridge No. 15.3 over Isaac Creek, B.C., Division, Arrow Lake Subdivision, rescinding Order 15681 of December 26, 1911.

15712—December 29—Authorizing C.P.R. to cross with its Estevan-Forward Branch thirty-nine highways in Saskatchewan.

15713—December 30—Approving revised location of C.N.O. Ry. near Nipigon, Ont., mileage 497.16 to 498 from Sudbury Jct.

15714—December 30—Authorizing C.N.O. Ry. to cross eight highways in Twp. of Toronto, County of Peel, Ont.

15715—December 19—Authorizing G.T.R. to take certain lands in city of Kingston for enlarged railway facilities.

15716—December 27—Suspending G.T.P. Local and Joint Passenger Tariff C.R.C. No. 129 relating to "baggage of excess size" until all parties can be heard.

15717—December 19—Approving C.P.R. revision of grade between St. Martin's Jct. and Ste. Therese, and to construct across with double track six highways.

15718—December 15—Amending Order 7112, May 18, 1909, re London Street bridge, Windsor, Ont., and Michigan Central Railroad Co., substituting another plan and providing that new bridge be built during 1912.

15719—January 2—Naming William M. Tisdale, attorney at law, Redlands, Cal., and J. P. Hartman, attorney at law, Seattle, Wash., as commissioners for examination of witnesses in Dawson Board of Trade vs. White Pass & Yukon Route Railways Rate Case.

15720—November 27—Dismissing application of Jos. Hoolahan, of Ste. Agatha des Monts, re rates charged on perishable shipments by C.P.R.

15721—December 30—Authorizing G.T.P. Ry. to construct transfer track to connect with C.N.R. at Portage la Prairie, Man.

15722—January 2—Authorizing Midland Railway Co. of Canada (G.N. Ry.) to operate crossing for construction purposes only until 10th March, 1912, at connection with C.N.R. and crossing of G.T.P. Parish of St. Boniface, Man.

15723—December 30—Authorizing C.N.O. Ry. to construct over Rideau Canal and Rideau River by bridge at Smith's Falls.

15724—November 21—Disallowing tariffs of G.T.R., C.P.R., C.N.O., C.N.Q.R., Quebec, Montreal & Southern, Central Vermont, Ottawa & New York, Central Ontario, 1000 Islands, and Lotbiniere & Megantic, and N.Y.C. & H.R.R. and Rutland Railroads increasing rates on hay and straw from Ontario and Quebec to eastern United States points. These rates were postponed by Order 15080, October 12, 1911, until January 1, 1912, and are now disallowed.

15725—December 16—Directing C.P.R. to, before May 1, 1912, give Samuel Plunkett, of Twp. of Vaughan, County of York, Ont., as good grade over new crossing as over old one before track was elevated.

15726—January 3—Extending until February 15, 1912, time for filing tariffs by G.N.R. on fertilizers for W. H. Haight, Piper's Siding, B.C., from Vancouver and New Westminster.

15727—December 19—Directing G.T.P. Ry. to construct station on Lot 882, Group 1, Cassiar District, B.C., and restraining said company from locating station on Lot 851, Group 1, Cassiar District, B.C. Application Robert Kelly, of Vancouver, B.C.

15728—January 3—Authorizing C.N.O. Ry. to cross public road between southeast and southwest parts of Lot 15, Con. 1, Twp. of Toronto, County of Peel, Ont.

15729—January 2—Authorizing C.P.R. to construct spur for Shawinigan Water & Power Co., Parish of Notre Dame du Mont Carmel, County of Champlain, Que.

15730—January 2—Refusing application of G.T.P. Ry. for approval of location of its Prince Rupert Westerly Line mileage 6.60 to 3.23, Range 5, Coast District, Province of British Columbia.

15731—January 3—Directing C.P.R. to, before May 1, 1912, provide a suitable farm crossing for James Connelly, of Macleod, Alta.

15732—January 3—Directing C.P.R. to, before June 1, construct cattle pass for James Smith, Wolffton, Sask.

15733—January 4—Authorizing C.P.R. to operate siding to Union Stock Yards Co., at Toronto, Ont.

15734—January 3—Amending Order 15580, December 11, 1911, costs of protection to be paid, one-third by G.T.R. and two-thirds by T., H. & B. Ry.

15735—January 2—Directing G.T.P. Ry. to remove suffcient rock fill at Cameron Bay, Prince Rupert, B.C., and to file with Board before February 15, 1912, plan showing location of opening and depth of girders for carrying track, etc. Complaint of firms of Prince Rupert, B.C., re obstruction caused navigation at Cameron Bay.

15736-37—January 5—Approving location of C.N.O. Ry. (Montreal-Port Arthur Line) through Twps. of Widdifield, Commanda, Beaucage and Pedley, District of Nipissing, mileage 346.37 to 366 from Montreal; and through Twp. of Capreol, same District, mileage 0 to 71.81 from Capreol Junction.

15738—January 4—Authorizing C.P.R. to construct two spurs to premises of Port Arthur Wagon Co., Ltd., Port Arthur, Ont.

15739—January 3—Authorizing C.N.O. Ry. to construct branch line from Oshawa station to town of Oshawa, mileage 0 to 3.95, to connect with tracks of Toronto Eastern Ry. Co.

15740—January 4—15741—January 3—15742—January 2—Authorizing C.P.R. to construct spur to premises of Strome Milling and Grain Co., Ltd., at Strome, Alta., and into premises of Swift Canadian Co., Ltd., Winnipeg, Man., also for Messrs. E. Julian Co., Ltd., city of Quebec.

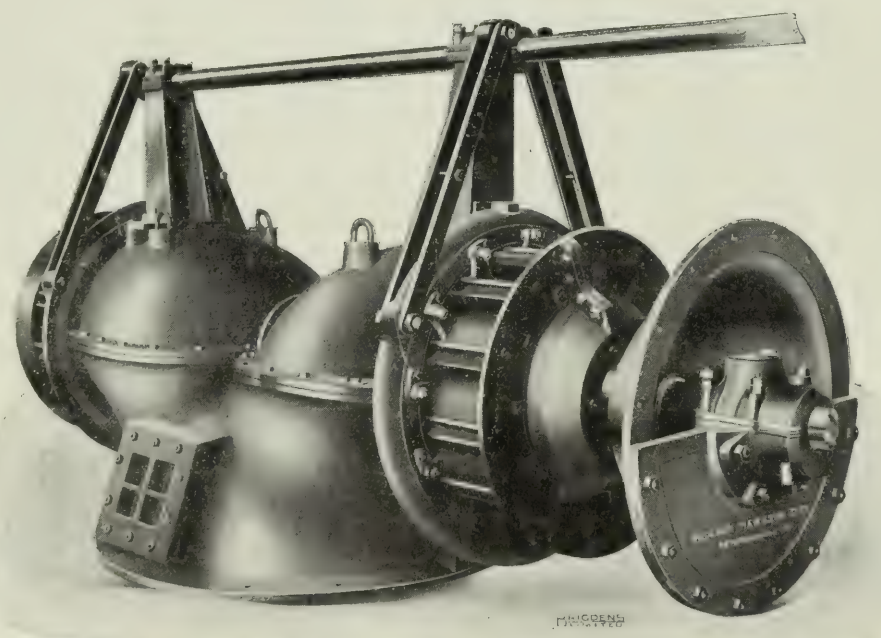
15743—January 4—Authorizing C.P.R. to reconstruct bridge 63.8, Brandon Subdivision, Manitoba Division.

15744—January 3—Relieving C.P.R. from further protection at crossing in village of Campbellville, Ont.

15745—January 3—Authorizing T.H. & B. Ry. to construct spur for Armstrong Supply Co., Ltd., Hamilton, Ont.

15746—January 3—Authorizing G.T.R. to construct spur for Messrs. Schell Bros. and Blow on Lot 49, 1st Con., Twp. of North Cayuga, County of Haldimand, Ont.

15747—January 3—Relieving G.T.R. from further protection at crossing 1½ miles east of Glencoe, Ont.



Water Wheel Installations

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WILLIAM HAMILTON COMPANY, Ltd., Peterborough, Ont.

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The Canadian Engineer

An Engineering Weekly

THE WATERPROOFING OF SEWERS

The subject of ground water infiltration into sewers is an exceedingly important one where it is necessary to pump and purify a large part of the effluent. A topical discussion of the subject is published in the proceedings of the National Association of Cement Users, for 1911, from which the following is abstracted.

Mr. George T. Hammond, designing engineer of the Brooklyn Bureau of Sewers, presented the following data:

New Orleans, La.—The plan provided for the removal of 0.003 cu. ft. per sec. per acre of ground water, or 1,250,000 gals. per sq. mile per day. In 1909 one sewage pumping station had an average dry weather discharge of 20,000,000 gals per day, of which "probably 15,000,000 gals. is ground water, which is being absorbed continuously from the soil of the city, lowering its moisture line in the soil and vastly improving its sanitary condition."

The sewers of New Orleans were constructed with great care, on the separate system, and Mr. Hammond considers the system one of the finest in the world. It is so located that the pumping of ground water is a distinct advantage to the city. Therefore, no waterproofing was undertaken, but the joints were all made as tight, and the work was constructed as water-tight, as such work can be made without special provision for waterproofing. The surface of the city is lower than the surface of the Mississippi River, except along the levees. However, the result well illustrates the freedom with which ground water enters well constructed sewers that have not been specially waterproofed.

The pipe sewers, from the smallest size up to 36 ins. in diameter, are of the very best quality of vitrified stoneware pipe. The main sewers are principally of brick, although there are also several miles of concrete sewer of sizes from 3 ft. 9 in. to 5 ft. 9 in. in diameter.

Brooklyn, N.Y.—The portions of the system in low ground admit considerable ground water. In one section of the city which contains about 200,000 population, and in which the dry weather flow is pumped and treated, from 5 to 20 per cent. of the flow, in accordance with the season, is estimated to be ground water. The total dry flow varies from 15,000,000 to 20,000,000 gals. per day. The system consists of brick main sewers, and of vitrified and concrete pipe collectors. The two kinds of pipe are used in about equal quantities. The maintenance cost per mile per year is about equal on each kind of pipe and is very low. Maintenance cost of brick sewers per mile is about four times as great. At Coney Island the leakage into sewers ranges from 20 to 50 per cent. of the flow, all of which has to be pumped. The Sewer Bureau is relaying much of this leaky system with sewers having carefully waterproofed joints.

Reading, Pa.—The water supply is 127 gals. per capita. The sewage is 163 gals. per capita. The infiltration of ground water amounts to 5,172 gals. per mile per day. The system is practically new and is constructed of vitrified pipe, and brick and concrete mains.

Providence, R.I.—The amount of sewage pumped in 1905 was as follows: Daily average for the year, 21,706,889 gals.; daily average for wet weather, 32,131,655 gals. This was an increase of about one-half in wet weather. The system is a separate system. The sewers, from 16 ins. in diameter up to the largest size, are brick. The pipe sewers range in size from 6 to 15 ins., and are partly iron and partly vitrified pipe.

Baltimore, Md.—In the new system being installed, notwithstanding careful waterproofing of interceptors, and the use of waterproofed joints, provision is being made in the size of the sewers for the entrance of some ground water. The Board of Consulting Engineers say, in their report to the sewerage commission (1906):

From our experience with this subject in other places, it is our opinion that in the earlier years of the new works, the total amount of the sewage would not exceed the water supply. In subsequent years, when the sewers are extended into less thickly populated portions of the city, and buildings are more generally connected with the sewers, the sewage increased by ground water will be materially in excess of the water supply.

The board advised providing for 150 gals. of flow per capita with sewers designed to flow half full with this quantity. The system is separate. Vitrified clay pipe is used for all pipe sewers.

Columbus, O.—Ground water entering sewers, when ground is wet after storms, is about 100 per cent. of the dry weather flow; during storms it ranges from 100 to 296 per cent. of the dry weather flow. System is built of brick, vitrified clay and concrete.

Kalamazoo, Mich.—Ground water entering sewers is about 20 per cent. of their capacity. System formed mainly of vitrified clay pipe.

Norfolk, Va.—Ground water forms 60 per cent. of the pumping. Sewers are brick, vitrified clay and iron pipe.

Canton, O.—Main sewer admits ground water at the rate of 70,000 gals. per mile per day.

Brockton, Mass.—The ground water flow is said by reports to have been 400,000 gals. per day from 16 miles of sewers, or 25,000 gals. per mile per day.

Red Bank, N.J.—Strictly separate system. No storm water is supposed to enter, but after a shower the flow quickly doubles in quantity. Vitrified clay and iron pipe are in use.

Vineland, N.J.—Strictly separate system of sewers constructed of vitrified pipe. The flow in wet weather is nearly double that in dry.

Westfield, N.J.—Strictly separate system of sewers constructed of vitrified clay pipe. There are about 15 miles of sewers 8 ins. to 24 ins. in size. The ground water entering the sewers increases the ordinary flow about 50 per cent.

Further interesting data on the amount of ground water infiltration are given by Mr. Kenneth Allen, chief engineer of the Metropolitan Sewerage Commission of New York. The following figures are from Mr. Allen's discussion.:

In Providence, R.I., the infiltration has been estimated at 47 gals. per capita per day.

In Waterbury the infiltration to a concrete sewer about 4 ft. 5 ins. square laid under a head of from 4 to 12 ft. amounted to one gallon per second for every 400,000 sq. ft. of interior surface, or 0.218 gal. per sq. ft. per day.

The infiltration of 140 miles of sewers in Massachusetts towns has been estimated at 40,000 gals. per mile daily. Taking the larger systems of the state it has been estimated at 70,000 gals per mile.

In the metropolitan system near Boston it has averaged 40,000 gals. per mile before making connections.

In their report on a system of sewerage for the city of Baltimore in 1897, Messrs. Hering and Gray recommended an allowance of 750,000 gals. per sq. mile in the low-lying districts near the harbor, and 100,000 gals. per sq. mile per day in other parts of the city. In 1906 Mr. F. P. Stearns proposed an allowance of from 30,000 to 80,000 gals. per mile of sewer daily. In later estimates 12 gals. per capita have been assumed.

Mr. C. E. Grunsky estimated for the sewerage of San Francisco a daily volume of 55,300 gals. per sq. mile for pipe sewers and 166,000 gals. per sq. mile for brick sewers.

In Peoria, Ill., the infiltration was estimated at from 50,000 to 100,000 gals. per mile for sewers in wet ground. In the case of brick sewers it was estimated at 15 gals. per sq. ft.

The above figures show the variation in the amount of ground water infiltration and indicate how serious the problem may become in some cases. Mr. Hammond considered it likely that his list could be extended to include nearly every sewer system installed in this country previous to 1900, and many since installed.

Methods of Waterproofing Sewers.—As Mr. Hering points out, waterproofing may be applied in three general ways. One way is to have the material of the structure and the joints impervious. This will prevent leakage in either direction. Another way is to coat the outside of the sewers if the object is to prevent infiltration of ground water into the sewer. The third way is to coat the inside of the sewer if a leakage of the sewage into the ground is to be prevented.

Mr. Hammond submits the following classification of the causes of failures and leaks in pipe sewers: 1. Pipe of improper material for sewers. 2. Defective or broken pipe. 3. Defective joints. 4 Defective house connections. 5. Improper foundations. 6. Careless or improper backfilling of trenches. 7. Improperly constructed brickwork and concrete. 8. Disintegration of pipe or masonry, caused by chemicals or impurities in solution in the sewage or in the ground matter, and from steam admitted to the sewers. 9. Failures from other causes not classified, as unexpected contraction and expansion, impact, etc.

Mr. Hammond discusses waterproofing methods as follows:—

"The waterproofing of sewers is perfectly practicable. The extent to which it should be employed, and the best method adaptable to a given case, are the problems to be met, as well as the probable length of time during which the waterproofing employed will continue effective, and the best should be selected for each special case.

"There are various methods here for producing the effect, as elsewhere. Coatings of bituminous materials may be applied to the external surface of the sewer, and gaskets dipped in tar or maltha or hot asphalt may be employed in the joints; or the whole interior of the sewer may, in the case of large masonry structures, be treated with a plaster. Again, the sewers may be designed to be built of concrete pipe rendered impervious by exterior coatings of asphalt paint or maltha; or by having an antihydrous waterproofing compound mixed with the cement used in the concrete. Recent experiments seem to show that even the admixture with the concrete of clay, or various other substances, will produce a dense and waterproofing material. Concrete rendered impervious by one of these methods may be used in forming the larger sewers in place, and in making the manholes and other appurtenances. Also, in the construction of pump wells and disposal works; and in various instances this method may be supplemented by the use of bituminous exterior coatings.'

"In Baltimore, where the most elaborate and extensive system of sewers now under way in this country is being constructed, and no detail is being lost sight of or expense spared which could render the system more perfect, the intercepting sewers are being treated with a complete waterproof coating."

In addition to the data given by him on the amount of ground water infiltration, previously quoted in this abstract, Mr. Allen discussed the methods and cost of waterproofing sewers. We quote, as follows:

"In the case of vitrified pipe sewers, if these are sound and of good quality, it only remains to secure an impervious joint. This is not practicable with natural cement. With Portland cement mortar following a gasket saturated with grout and carefully calked there will be very little leakage. The difficulty lies in ensuring perfect work, especially in a wet trench, and the possibility of cracking the joint by settlement in a soft soil. To overcome these objections various substitutes for the cement mortar joint have been used with more or less success.

"With a firm bed or foundation a mixture of 1 part of fine sand with 1 part of flour of sulphur heated to about 230° F. poured in the joint over a well calked gasket is said to give a water-tight joint costing for an 8 in. pipe 12 cts., for a 15 in. pipe 19 cts. and a 30 in. pipe 30 cts. Possibly leadite, which is somewhat similar in character and which the writer has used successfully for cast iron pipe joints would answer equally well. Either of these materials will provide a strong and unyielding joint, so that in case of settlement an undue strain is brought to bear on the bell.

"For yielding soils the writer believes some form of bitumen may eventually be found that will be both elastic and impervious. For a number of years Mr. J. H. Decker has used a paste made by kneading cement and pine tar pitch by hand until of the consistency of dough in the sewers of Atlantic City with success, the material being pressed into the joint by hand. The writer employed this method in laying about ¼ mile of conduit of 8 in. to 20 in. vitrified pipe conveying water from a series of artesian wells to a reservoir. Testing under a head of 3 or 4 ft. after completion, the line was found to be almost absolutely water-tight. This joint, although setting quite hard, remains sufficiently pliable to conform to ordinary settlement without injury.

"In Baltimore, Mr. E. B. Whitman experimented with a joint which proved so satisfactory that a considerable amount of vitrified pipe has been laid in wet trenches in the sewerage of that city with bitumen joints. The specifications provide that the inside of the bell and at least 4 ins. of the spigot end shall first be painted with a thin paint consisting of a solution of bitumen and gasoline or turpentine. Two or three pipe lengths are usually joined together before lowering to the trench by first centreing and packing with a thin gasket of hemp or jute well calked and then filling the joint full of hot bitumen, heated sufficiently to expel bubbles but not so as to render it brittle. The bitumen may be the refined natural or artificial material or a mixture of both, but must not have a melting point lower than 170° F. or be brittle when cooled to 30° F. It must also be of such a consistency that a fragment will not materially alter in shape when kept in

ordinary temperatures and must have a moderate degree of resilience.

"As a test it is specified that 3 lengths of 8 in. pipe joined in this way and resting on supports 7 ft. apart shall carry a centre load of 200 lbs. without failure or excessive deflection, and that after such tests the joints shall show no leakage when subjected to a hydrostatic pressure of 5 lbs. per sq. in.

"Asphaltic joints have been used to a considerable extent in England and Germany, and the writer has long believed that a field would open for them in this country under conditions where cement work would be injured by washing or, later, by cracking.

"With larger sewers it is desirable to employ concrete in preference to brick if watertight work is desired. There is no question but that reasonably tight work can be secured by using correct proportions and a wet mixture, but additional safety may be had by the use of waterproofing compounds by the judicious admixture of lime or clay to the concrete or by the application of a layer of waterproofing material. The writer believes that the latter safeguards are rarely required in sewer work when good work can be relied on by contractor and inspector.

"In the construction of the west low level interceptor at Baltimore, waterproofing was applied to the interior surface of the concrete and a brick ring added inside to protect this. The diameter on sections 1 and 2, which lay along the waterfront with the invert from about 11 to 13 ft. below tide level, were from 74 to 84 ins. The invert was first swabbed with hot Trinidad asphalt upon which was placed a layer of 10 oz. burlap. This was then rubbed down and painted with hot asphalt, a second layer of burlap applied and this was then brushed down and saturated with a third coat of asphalt. The brick ring was then laid complete and the waterproofing carried over the brick arch. The concrete arch was finally laid on this.

"Some difficulty was experienced at first from the water which dripped on the tops of the side walls and found its way between the waterproofing and concrete of the invert, forming blisters 1 or 2 ins. in diameter. Where this occurred the blisters were pierced, emptied and patched. To prevent its recurrence channels were left in the tops of the side walls to cut the flow from outside and the lap of the burlap rolled up and covered with canvas to keep it as dry as possible.

"In forming the joint with the waterproofing of the arch the layers were lapped in pairs and an additional strip of burlap added outside, making the waterproofing at this most troublesome location 5-ply.

"To drain the channels left in the side walls 3 in. terra cotta drains were inserted, occasionally running down through the side walls to a quarter bend and thence to the gravel near the under drain.

"If the burlap got wet, as was sometimes inevitable, it was dried with a gasoline torch, although in extreme cases this was not practicable. To dry the invert before waterproofing, if too damp, gasoline was sprinkled on and lighted, but in sparing quantity to avoid injury to the concrete. At other times it was merely sprinkled with dry cement, which absorbed the moisture and was then brushed off.

"Estimates of the actual cost were made from time to time with the following results:—

	Per lin. ft.
Cost of waterproofing 84-in. sewer	$1.60
Cost of waterproofing 80-in. sewer	1.53
Cost of waterproofing 76-in. sewer	1.45
Cost of waterproofing 74-in. sewer	1.41

Cost per square yard:

Burlap at 6.9 cents per square yard	0.17
Asphalt at 25 cents per gallon	0.48
Labor	0.18
Total	$0.83

"The force employed usually consisted of a foreman, two laborers and two helpers.

"On section 3 the cost was reduced by the substitution of tar pitch for asphalt. Difficulty was experienced in securing a material that would neither be too soft at high temperature nor brittle at low temperature, but in other respects the results appeared satisfactory. The tar pitch cost $8 per 1,000 lbs., resulting in the cost for this material of but 15 cents per square yard of waterproofing.

"After the completion of the 3,590 lin. ft. of interceptor, about 100 ft. of which passed under the bed of a tidal stream, the leakage, including that from over 2,700 ft. of house connections and a considerable inflow around a bulkhead at the upper end of section 2, amounted to 11.16 gals. per min., or 0.223 gals. per sq. ft. of interior surface of interceptor (only) per day. The actual infiltration through the interceptor was practically nothing, as the water observed entered chiefly around the bulkhead mentioned, through the laterals or at the junctions with the interceptor. Probably 1/10 gal. of ground water per sq. ft. per day would be a liberal estimate in estimating on similar work. Considering the relative elevation of the ground water and the great difficulty in keeping the burlap at the spring-line dry while turning the brick arch, the final result was most satisfactory."

DRAFTING OF FORMS EFFECTS BIG SAVING EVEN ON SMALL, PLAIN JOB.

It is generally recognized that one of the prime reasons for the comparatively high first cost of reinforced concrete buildings is the cost of the material and labor put in the forms. Therefore continued efforts to reduce this item to a minimum are being made by many construction companies. A recent case of the Aberthaw Construction Company, of Boston, is illustrative of the possibilities of saving even on small jobs by designing the forms in the drafting room instead of putting the fitting up to the carpenter shop.

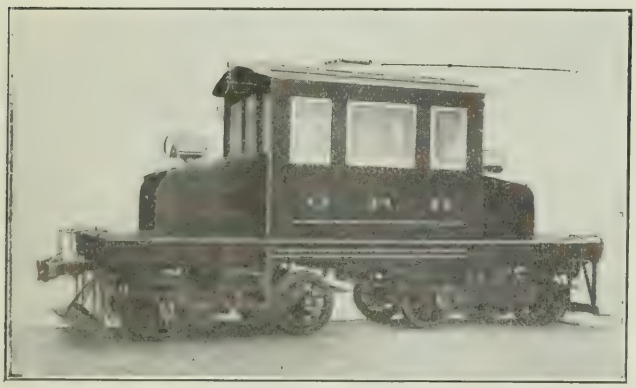
The job in question was a small structure costing about $26,000, and 50 ft. x 50 ft., four stories high. The design was of the beam and girder type, and was made as regular as possible in order to keep the cost down. In spite of this 115 different kinds of forms were required, making a total of about 500 forms in all, taking about 10,000 sq. ft. of stock. When it is considered that figures do not include any of the ledges, studs, or anything but the beam and column sides, it will be appreciated that 113 different kinds of forms is a large number for a plain, small job.

According to the company's former methods the carpenters not only made the beam sides but fitted them as they went along, and each one had to be sawed out. A large saving is therefore made by designing the forms for this small job in the drafting room, as the cost of drafting is very much less than the cost of making up the beams and fitting. It is very probable that the failure of new concrete contracting companies is often due to their ignorance of economical methods of handling form work, and the case above is an excellent illustration of how they might go astray on their estimate by not realizing the high cost of the many forms on such a small plain job.

27-TON LOCOMOTIVE FOR THE GUELPH RADIAL RAILWAY COMPANY.

The Guelph Radial Railway, Guelph, Ont., has recently purchased a 27-ton Baldwin-Westinghouse direct current locomotive. The cab, trucks and all mechanical parts were built by the Baldwin Locomotive Works, and the electrical equipment, including motor and control, was furnished by the Canadian Westinghouse Co., Limited, of Hamilton, Ontario, after the design of the Westinghouse Electric & Manufacturing Company, of East Pittsburg, Pa.

This locomotive is compactly built and may be used for freight and switching service. Interurban and city railways are using locomotives like this one and larger for various kinds of service, for a road's earning capacity can be materially increased by using locomotives to haul freight during the night or idle hours, thus improving the load factor. Many city roads also use similar locomotives for hauling construction material and refuse to dumping grounds.



New Locomotive for Guelph Radial Railway.

The Guelph Radial Railway locomotive is ruggedly built. The frame is of channel iron construction, and the cab is substantially built of clear ash fitted together with joint bolts and corner plates. The trucks are of the standard Baldwin electric M.C.B. equalizer-bar type with chilled cast iron wheels.

The electrical equipment consists of four type No. 101-B-2, 40-h.p., 500-volt Westinghouse railway motors and K-28-B control. It is also equipped with Westinghouse automatic and straight air brakes, with outside equalizing driver brakes.

The principal dimensions are:—

Length over end sills	23 ft. 0 in.
Width over all	8 ft. 0 in.
Truck centres	12 ft. 0 in.
Rigid wheel base	6 ft. 0 in.
Total wheel base	18 ft. 0 in.
Wheel diameter	33 in.

The hauling capacity of this locomotive is given in the table below:

Number of cars weighing 45 tons with load at 10.75 miles per hour at 500 volts.

Straight level road.	*Maximum Grade. ½%	1%	2%
17 cars.	7 cars.	4 cars.	2 cars

*On a fairly level and straight road, the load to be handled is determined by the maximum grade.

The figures given for "straight, level road" show the load which may be handled in switching service. The values given under "maximum grade" are safe when the grade requires a pull of but five or ten minutes' duration. In any particular case, the number of cars that can be handled may be greater or less than the values above tabulated, depending upon the profile curves and operating conditions.

HINTS FOR DRAINAGE SURVEYS.*

By I. W. Hoffman.

In many localities some drainage work has been done that proved to be no good. Usually it has been done without a survey, and it all had to be abandoned, and the work done over again.

In making preliminary surveys for county drains or drainage districts, I use stations 100 ft. apart, and only drive marker stakes. I take the levels simply on the ground, and when construction commences, put in the pluses and replace the markers, if any have been obliterated. On tile drains I put in plus stations every 50 ft. In that way the profile will be accurate and the exact depth of cut ascertained, or very nearly so. The profile should show the depth of the cut. It is well to put records of bench marks on the profile, as well as the length of drain that passes through the property of the different land owners; also the intersections with different subdivision lines and roads or highways.

The map should be made so as to show the surface conditions of the district (the points of the wet land, low land, or high land) and it should be as nearly accurate as it is possible to make it. The better the map is made, the more easily the board of supervisors can determine conditions in the district. The tracings of the map and profile should be kept by the engineer, and not allowed to be handled by the board of supervisors or other persons to any great extent. Blueprints can be made from these and filed in the reports. By the direct white-print process the map is made direct from the tracing and it shows everything plainly. It is made exactly as a blueprint. You do not have to make a negative; simply expose your tracing about seven minutes in bright sunlight, wash it, and you have a white print. You have a map then that can be taken by the commissioners and the classifications can be written on each 40-acre tract.

The engineer should make a complete and comprehensive report to the board of supervisors on every drainage district that he lays out. It is better to put in a little too much than not enough, so that the board will fully understand the conditions, the descriptions of the various drains, their approximate cost, and any recommendations the engineer sees fit to make. The engineer should keep a copy of everything that he does in his office. If some of the papers get lost in the auditor's office, which may happen, he then has copies to which he can always refer.

The engineer should try to attend all board meetings, but especially should he be present when the drain is to be established. These board meetings may sometimes be very animated, but he should face the music. It is particularly desirable for him to attend the meetings also when final action is taken on the assessment of benefits. There may be things that the engineer can explain to the satisfaction of the board and to the satisfaction of the land owner.

The engineer should try to accommodate the landowner in all things that can fairly be done. A landowner may wish a slight change sometimes, before the work is finally established or before the report is made. If he can be accommo-

*From the Proceedings of the Iowa Engineering Society, 1911.

dated without infringing on the capacity or use of the drain, this should be done.

The lines for the drains should be run as straight as possible, at the same time the line of the drain should follow the lowest depression. The engineer is one of the commission to appraise the damages in a drainage district. The damages asked for are sometimes a great deal more than will be allowed by this commission. The commission on damages should use judgment, and not allow any more than is fair and just.

The assessment of benefits is a very hard proposition. The drainage district should be examined very closely, each tract by itself, and all of the facts weighed and sifted until an equitable apportionment can be made by these commissioners. If this apportionment of taxes has been made in a just and fair manner, the board of supervisors should not change it. A great deal of trouble has resulted by boards changing the assessment.

The engineer and contractor should be on good terms always. The engineer should use judgment and have the contractor work to the line, but should not unnecessarily hamper the work of the contractor, who often has a very hard job before him. The drains should be laid out and constructed upon the best lines and no deviation made from them, and they should be constructed in such a manner as to do the most benefit to the land. The people are paying for it, and they expect the construction of these drains to be such as will be a benefit to them.

ACTION OF WATER ON LEAD PIPES, ETC.

Before the Chemical Section of the British Association, Dr. F. Clowes presented a paper on the action of distilled water on lead. When some years ago it was proposed to bring large volumes of soft water from Wales to London, the possibility of the action of this water on leaden pipes had to be investigated. Dr. Clowes had experimented with large sheets of very pure commercial lead. This lead was not acted upon by distilled water in a vacuum nor in an atmosphere of hydrogen; at any rate, the action, due probably to the last traces of oxygen, was infinitesimal. But supply waters always contain oxygen and also other gases. Of these gases, oxygen when alone present attacks the lead worst; carbon dioxide has a very slight effect; in equal mixtures of oxygen and carbonic acid the effect is quantitatively that of the oxygen, and when more CO_2 is present the action becomes less pronounced. The corrosion of the lead is hence primarily due to oxygen; the carbon dioxide acts in the second place by forming a carbonate with the oxide first produced. The action is rapid at first, and a white deposit is formed, while some lead passes in solution; the deposit in some hydroxycarbonate of variable composition. It has been suggested that the presence of bacteria was required to start the attack, or would hasten it; but heated lead corroded as quickly in water which had long been kept boiling as under ordinary conditions. These experiments demonstrated, however, the inhibitory influence of certain salts in the water. When water is distilled with the aid of a glass condenser tube, some silicate passes into the distillate, and this silicate protects the lead against corrosion. The water was therefore distilled from copper vessels and passed through copper coolers in some experiments. Sulphates also protect the lead, carbonates and carbonic acid are less efficient, lime is doubtful, and may even increase the corrosion if sufficiently concentrated. It is also due to this protective power of salts that distilled water does not acquire its full corrosive activity on subsequent aeration by exposure.

PROTECTION OF STEEL PIPES.*

By Alfred D. Flinn.

One of the siphons of the aqueduct under construction to supply New York City with water from the Catskill mountains was described in our issue of August 23. At that time the steel work of the siphon had not been completed, and consequently only a brief description was given of the protection, both inside and out, which was contemplated. In a paper before the New England Water Works Association, Alfred D. Flinn, Department Engineer of the Board of Water Supply of New York City, described the methods employed for furnishing inside and outside protection to this siphon and to the others along the line of the aqueduct. Of these siphons there are fourteen, ranging in length from 608 feet to 6,671 feet, the total length of all the siphons being 33,031 feet. About one-fourth of the total length has a finished inside diameter of 10 feet 11 inches, about one-fourth a diameter of 9 feet 5 inches and about one-half a diameter of 9 feet 2 inches.

While preparing the plans, investigations and experiments were conducted to determine the material and method which it would be best to adopt for protecting the steel. Apparently none of the pipe coatings commonly used possessed qualities giving it more than a few years' useful life when in contact with the water and soil which had to be considered in this case. One or two cases of the use of Portland cement mortar on a small scale and wide experience in reinforced concrete construction suggested the use of cement for this purpose; and after some study it was decided to jacket the siphons outside with rich concrete, with a minimum thickness of 6 inches and line them with Portland cement mortar 2 inches thick. An effort was then made to find the most economical and practical methods for the various steps in covering and lining the pipe, with a view also to obtaining intimate, complete and permanent adhesion in spite of the unavoidable changes in shape and the elastic distortions of the pipe.

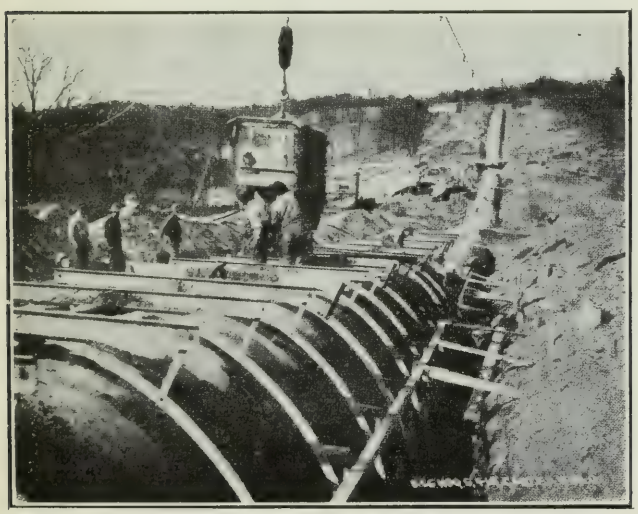
Mortar lining experiments were made on a steel pipe 9 feet in diameter and 12 feet long. This was lined by plastering with metal reinforcement of several styles, by plastering with terra cotta and cement blocks or tiles, and by pouring grout or very thin mortar into the space between a cylindrical steel form and the interior surface of the pipe. These experiments seemed to show that no combination of plasterer's skill with various kinds of cement mortar, reinforced or unreinforced, gave linings that were adequate; besides which this method was expensive. Bedding tiles of terra cotta or mortar, about ¾ or ⅞ inch thick and 6 by 8, 6 by 12, and 8 by 12, on mortar applied directly to the pipe surface, and, after setting, building up the lining to the required thickness with successive coats of mortar troweled on, was much more satisfactory, but also expensive. The grouting method proved by far the most satisfactory and least expensive and was made the basis of the specifications. It had the advantage of producing a monolithic lining, which was considered desirable, especially as it avoided layers or laminae, since it is well known to be difficult to cause one layer of Portland cement mortar or concrete to adhere absolutely and permanently to another without expensive and troublesome precautions. This method also gave promise of being feasible in actual construction, and was adopted for the work.

The specifications as adopted provided that the pipe should be tested by filling with water, should be made tight

*Abstract of paper before the New England Water Works Association.

while under pressure, and while still under the normal pressure should be surrounded with concrete, the pipe being kept under hydrostatic pressure until the concrete last placed had set for at least 48 hours. The water was then to be withdrawn from the pipe and the interior lined. It was provided that the lining should consist of Portland cement and sand mixed in such proportions as might be ordered, but probably one part of cement to two parts of sand. The lining was required to be of substantially uniform thickness throughout the entire circumference except for the unavoidable variations due to lap of the plates, butt straps and rivet heads.

The steel was required to be free from rust immediately before the application of either outer coating or inner lining. As a partial protection against rusting during transportation and construction, each pipe, after being pickled at the works, was given a coat of heavy lime whitewash, made as follows: To one barrel of whitewash (about 50 gallons), there were added 20 pounds of glue. After using this whitewash for a time, about one pound of Portland cement was added for each gallon of whitewash. The glue was dissolved in water before being added to the whitewash. The whitewash was applied with brushes, a machine for spraying by compressed air being found unsatisfactory. The whitewash did not adhere very well, some of it being removed almost as soon as applied. This temporary coating, however, did not suffer from abrasion or cracking off so much as from exposure to the weather; and even where the whitewash was not disturbed, light rusting occurred. In fact, the pipes arrived at the trench with more or less complete coats of light yellow rust; but there were no indications of any tendency to pitting, and the rust and the whitewash which remained were removed, before applying the concrete or mortar, by the use of wire brushes, although for some of the worst places steel scrapers were also employed. Inside some of the siphons the surfaces of the plates were rubbed with empty cement bags after the wire brushing.



Placing Concrete in Jacket, Showing One Type of Forms.

The methods employed for placing the concrete jacket were practically the same as those commonly used for concrete conduit construction, in which steel centres take the place of the steel pipe. On one siphon three methods were employed in different parts; monolithic; the invert first, then the remainder; invert and side walls to the horizontal diameter, then the arch. The best contact between jacket and pipe was obtained when the concrete was placed monolithically. Incidentally it was found that dropping concrete on to the pipe so as to cause shock should be avoided, a two-foot drop being too great. Earth covering was placed immediately after the completion of the concrete jacket, to protect it from accident and from temperature changes. For this reason there has been little chance to observe what tendency to crack there may be; but so far as has been observed, there have been very few cracks in the jackets of any of the siphons built so far.

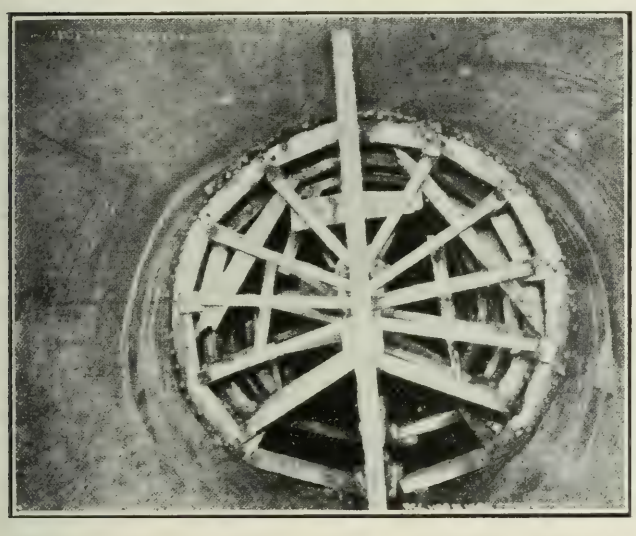
For lining the pipes two distinctly different methods were first adopted by the two contractors. On the northern half of the aqueduct, grouting with forms was employed, and on the southern half the mortar has been applied to the first siphon by the use of the cement gun. There were practical difficulties connected with the use of a complete cylindrical form, such as getting around curves, vertical or horizontal, collapsing one section of forms sufficiently to pass forward through another section which must remain in place while the grout is hardening; cleaning, lubricating and inspecting outside of form, etc. Consequently the invert for a width of about eight feet of arc has been placed first by methods similar to those of concrete sidewalk construction. These wide inverts have generally separated from the pipe along their edges, for one reason or another, so that a piece of steel tape could at places be pushed into the crack for several inches. To obviate this trouble trials have been made of inverts one foot to two feet wide.

In both contracts wooden forms in panels 2 feet wide and 15 feet long, adjusted on modern rings and firmly braced, were used for pouring the remainder of the lining in 15-foot sections at one operation. The grout is poured from outside the pipe through a 2½-inch wrought iron pipe secured into a rivet-passing hole. In the southern department this pouring pipe is at the downhill end of the section and is long enough to give a head of about four feet at the top of the uphill end. A vent pipe is fastened in the uphill rivet-passing hole of the section, the bulkhead forming the end of the lining being placed just beyond it. The contractor for the northern siphons used, for pouring grout, two mortar boxes set on a temporary staging over the upper end of the section to be grouted. The mortar was mixed to the proper consistency in alternate boxes and allowed to flow into the pipe through a hole controlled by a sliding wooden gate. All mixing was done by hand and materials were carefully graded. It generally took about two hours to fill a section, after which a man was kept on for another hour or two in order to feed in sufficient grout to get the desired consistency. There was a noticeable tendency to get a porous or thin condition at the upper end of the section near the grouting hole. To avoid this the riser was removed two or three times during the pouring and the thin material which collected at the top was allowed to escape; when the riser was put back and grout added as necessary. In some cases it took nearly two hours after the main operation to get grout of proper consistency at the foot of the riser. At the finish of the pouring a small pipe was inserted through the large pipe, to permit the escape of the last air while grout was being poured through the larger pipe, and was churned into the small remaining space to insure complete filling. For the first batches, or nearly up to the horizontal diameter of the pipe, the grout was mixed one part cement to one part sand; the upper part was mixed about one to two. The rate of pouring the lining depended upon the number of forms and men available. In lining the Foundry Brook siphon about two moves per week were made with each of twelve sets of 15-foot forms, the rate being about 400 feet per week.

The cement gun builds up the lining in layers, but these are applied in such rapid succession and each layer has such a rough surface that there is little or no lamination. It was impossible, however, to secure a satisfactory smooth finish in this way, and a final layer was applied and floated and

troweled before it hardened. In using this gun charges of dry sand and cement are placed in the chamber of the machine and then rapidly discharged by air under 50 to 60 pounds pressure through a rubber hose; water under pressure being brought by a parallel hose and combining with the cement and sand in a special nozzle. The nozzle pressure is about 30 pounds and the resulting velocity causes an excellent union between the layers; but it also results that a measurable proportion of the sand bounds off the surface of the pipe and falls to the invert, especially when beginning the first layer on the bare steel. This dry material, which averages one part cement to 3¾ parts sand, is collected and used in making the invert. The use of the gun causes the atmosphere within the pipe to be very dusty, and artificial ventilation is consequently necessary. The grout applied by the gun is considerably less moist than that poured within the forms, and consequently more attention is required to keep the lining moist in order to minimize shrinkage cracks, a considerable number of fine cracks having formed in the lining first placed in this way. In spite of these difficulties a satisfactory lining has been secured; but the contractor discontinued its use after completing one siphon, the reason given being excessive cost.

Absolute adhesion of concrete or mortar to the steel has



Wooden Form for Mortar Lining. Completed Lining in Foreground.

not been secured at all points, as has been proved by careful sounding with a hammer; but on cutting out hollow-sounding spots, the space between the mortar or concrete and the steel has usually been found almost infinitesimal in width. What effect this would have on the protective action of the lining was investigated by the Board's laboratory. One of these tests consisted in placing horizontally in a galvanized iron tank six steel plates 8 x 16 inches, separated from the bottom by two 1¼-inch bars of alberene stone and from each other by ½-inch wood dowels. The first pair of plates had no protective covering; the second pair had their upper surfaces protected by a slab of cement mortar 2½ inches thick, held from contact with the steel by two metal strips about .04 inch thick; the third pair of plates was protected by cement mortar slabs 2 inches thick, cast directly on the steel, and apparently adhering to it firmly. The tank was filled with Croton water to four inches above the uppermost mortar slab, the water being renewed twice monthly, and the slabs being immersed for two years. Each slab had been cleaned by pickling and rubbing with emery cloth before treatment. At the end of the two years the first plates showed heavy corrosion. The second pair of plates showed a very slight corrosion, most of which washed off, thus indicating a considerable protective influence under the conditions described. When the mortar was removed from the third pair of plates it was found that a part of the surface of the steel had a distinctly different appearance from the other part. One part was clean and wet; the other was covered by strongly adhering particles of mortar and was dry, thus indicating that there had been actual adhesion of the mortar over the latter part of the surface only, and that the former had been separated by a space large enough for the water to enter. There had, however, been no rusting except at some places near the edges of the wet part of the surface, where apparently the space had been sufficient to allow circulation of the water. The water in the rest of the space had evidently been so highly charged with lime that no corrosion could take place.

Another experiment was made by immersing ¾-inch round soft steel rods in slabs made of rather lean concrete which, after about two years, were broken and found to be thoroughly saturated, but the rods showed no sign of corrosion whatever. It is hoped that the pipes will last one hundred years and even longer, because of the cement lining. In addition, because of the gain in smoothness of the interior surface obtained by covering the rivet heads and plate laps, it is computed that the hydraulic capacity of the three pipes would be as great as that of four unlined ones.

The contract prices of the several siphons, all of which were let in two contracts, were as follows:

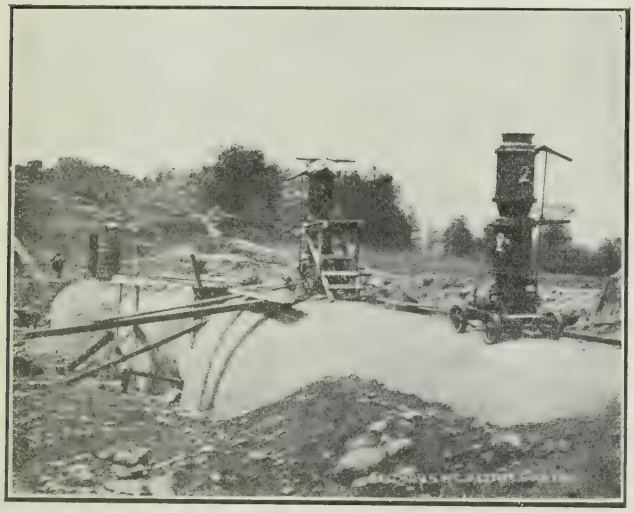
Contract Prices for Steel Pipes, Concrete Jacket and Mortar Lining.

Description.	CONTRACT 68. Contract price.		Average of all bids. (5 bidders.)	
9 ft. 6 in. steel pipe, 7/16-in. plate, lap-jointed	$31.00	lin. ft.	$35.50	lin. ft.
9 ft. 6 in. steel pipe, ½-in. plate, lap-jointed	35.00	" "	41.20	" "
9 ft. 6 in. steel pipe, ½-in. plate, longitudinal seams, butt-jointed	40.00	" "	44.80	" "
9 ft. 6 in. steel pipe, 9/16-in. plate, longitudinal seams, butt-jointed	43.00	" "	48.80	" "
9 ft. 6 in. steel pipe, 11/16-in. plate, longitudinal seams, butt-jointed	47.00	" "	55.80	" "
9 ft. 6 in. steel pipe, ¾-in. plate, longitudinal seams, butt-jointed	50.00	" "	50.60	" "
Mortar lining for steel pipes	2.50	" "	4.90	" "
Reinforcement of mortar lining for steel pipes	.02	sq. ft.	.03	sq. ft.
Concrete masonry around steel pipes	6.00	cu. yd.	5.85	cu. yd.
Portland cement	1.75	bbl.	1.74	bbl.

	CONTRACT 68.		(8 bidders.)	
9 ft. 9 in. steel pipe, 7/16-in. plate, lap-jointed	$29.00	lin. ft.	$33.25	lin. ft.
11 ft. 3 in. steel pipe, 7/16-in. plate, lap-jointed	33.00	" "	37.37½	" "
11 ft. 3 in. steel pipe, ½-in. plate, lap-jointed	38.00	" "	42.75	" "
11 ft. 3 in. steel pipe, ½-in. plate, longitudinal seams, butt-jointed	46.00	" "	48.75	" "

11 ft. 3 in. steel pipe, 9/16-in plate, longitudinal seams, butt-jointed	50.00 " "	53.62½ " "
Mortar lining for 9 ft. 9 in. steel pipe	3.00 " "	3.56¼ " "
Mortar lining for 11 ft. 3 in. steel pipe	3.50 " "	4.04½ " "
Reinforcement of mortar lining for steel pipe	.02 sq. ft.	.02¾ sq. ft.
Concrete masonry around steel pipe	5.25 cu. yd.	5.78 cu. yd.
Portland cement	1.60 bbl.	1.72½ bbl.

In immediate charge of the construction of the siphons are Division Engineers John P. Hogan, Alexander Thomson, Jr., and George P. Wood on the northern; and George



Cement Guns Resting on Concrete Jacket.

G. Honness, Ernest W. Clarke and Charles E. Wells on the southern department. J. Waldo Smith is the chief engineer of the Catskill water works, Merritt H. Smith is deputy chief. Many of the investigations of existing pipe lines were made by the assistant to the chief, Department Engineer Thaddeus Merriman.

In discussing the matter of preparation of the steel, F. N. Speller, metallurgical engineer for a Pittsburg firm, highly approved of the careful removal of the mill scale. He stated that experiments in which two parts of the same plate, one with and the other without the scale removed, had been exposed to corrosion showed about the same loss of weight per unit area in both cases, but this corrosion was in the form of deep pitting in the uncleaned surface, but uniformly distributed and with little damage in the other. A 5 per cent. solution of sulphuric acid, heated to about 180 deg. Fahr. when used, he thought the most effective conditions for removing scale by pickling.

BROKEN RAILS AND DEFECTIVE WHEELS.

In a recent report of the Interstate Commerce Commission of the United States, note is made of the number of broken rails and defective wheels. The Commission state that their attention has been called in numerous and in some instances startling ways, to the increased number of railroad accidents due to broken rails. The reports of accidents made to the Commission by carriers show that in the year ended June 30, 1902, 78 derailments were caused by broken rails, while in the year ended June 30, 1911, 249 derailments were due to the same cause. In the past decade 2,059 derailments have been caused by broken rails and have resulted in the death of 106 persons and injuries to 4,112 persons.

Exhaustive investigation was made of a wreck on the Lehigh Valley Railroad on August 25, 1911, in which 62 persons were injured and 29 persons lost their lives. There was and is no room for doubt that this wreck was caused by a broken rail. The Commission requested the co-operation of the Department of Commerce and Labor by its Bureau of Standards in examination of pieces of this rail. Inspection and careful analysis of same disclosed that the rail contained defect in manufacture and several other defects in the form of transverse fissures. This rail was manufactured in December, 1909, and was laid in the track in October, 1910. It had, therefore, been in use less than one year when the accident occurred. The reports of this accident suggest that the defects from use indicate that possibly the maximum weight of power and rolling stock that can safely be used on rails of present-day manufacture has been reached, if, indeed, it has not been passed.

Officials of railroad companies and of steel manufacturing plants are energetically pursuing careful investigations on this subject and apparently are determined to locate the difficulty and to correct it.

We deem it proper to call this situation to the attention of Congress, although we do not recommend that this Commission be authorized or directed to conduct an investigation in the premises. Any such investigation, whether conducted by carriers, steel manufacturers, or others, must of necessity be made on purely scientific lines, and if undertaken by the government there are doubtless bureaus in other departments that are equipped to do such work with competent men in the government service.

The attention of the Commission has been called to dangers in railroad operation from car wheels that are defective or composed of improper material.

The wide interchange of equipment between railroads necessarily frequently requires that broken or worn-out wheels shall be replaced on the lines of some carrier other than the owner of the car. It appears that such replacements are made under an agreed and standard price to be charged for the wheels.

We know of no existing statistics or information upon which statements as to the number of defective wheels discovered in service can be verified. No reports are made to the Commission of such instances unless a wreck or derailment is thereby caused. For the years ended June 30, 1902, 1906 and 1911, reports of accidents made to the Commission show for the respective years 538, 1,007, and 986 derailments caused by broken or defective wheels.

This suggests the possible desirability of requiring comprehensive reports from carriers as to the number of car wheels in use on their equipment and the number of same that have proven defective, by years, for the last decade. It is well known by all practical men that car wheels will crack from overheating by too long continued application of the brakes, and while presumably a wheel of poor material and workmanship would crack from this cause somewhat more readily than a wheel of good material and workmanship, it would seem proper in requiring such reports and analyzing same to differentiate wheels which are known to have been cracked or broken in this manner from those which have proven defective from other causes.

The suggestions already made as to an investigation of the quality of rails apply to any investigation undertaken as to the character and quality of material used in manufacturing car wheels.

METHODS OF REFUSE DISPOSAL FOR TORONTO.

In a report to the City Council, submitted on October 25th, 1911, Messrs. Rudolph Hering and John H. Gregory, consulting engineers, of New York, gave the results of their investigation into the refuse disposal question of Toronto. A digest of this report follows:

Four separate projects were considered: Two contemplated the incineration of the garbage, rubbish, and a portion of the ashes, (A) without and (B) with the utilization of the salable part of the rubbish. The other two projects provided for the reduction of the garbage and the incineration of the rubbish. (C) without and (D) with the utilization of the salable part of the rubbish. Street sweepings, dead animals, etc., are satisfactorily disposed of by the city's present methods and are not considered in the report.

The comparison of the four projects is based upon plant capacities sufficient to dispose of the refuse from a population of 600,000, which, it is thought, will be reached in 10 years; Toronto's population by the 1911 census is 376,240. The total weight of garbage, rubbish and ashes collected in Toronto amounts to about 0.55 ton per capita per year; the relative amounts per capita per year are, garbage 0.1 ton, rubbish 0.05 ton, and ashes 0.4 ton. On this basis the total estimated weight collected from a population of 600,000 would be 60,000 tons of garbage, 30,000 tons of rubbish, and 240,000 tons of ashes per year, a total of 330,000 tons.

Project A.—In this project it is proposed that all of the garbage and rubbish, together with ashes amounting to 20 per cent. of the mixture, be incinerated, the remainder of the ashes to be used for fill. With a population of 600,000 the average daily amounts to be incinerated would be: Garbage, 200 tons; rubbish, 100 tons; ashes, 75 tons; total, 375 tons. Studies of the cost of construction and cost of hauling led to the conclusion that two incinerator plants, each of a daily capacity of 215 tons of mixed refuse, would be sufficient. In project A it was assumed that the garbage and refuse would be collected together and the ashes separately. No boilers or equipment to produce power are considered in this project on account of the cheapness of electric power from Niagara Falls. As there is believed to be no market for clinker at present in Toronto no clinker mills are included in the cost of construction.

The cost of constructing the two incinerators is estimated at $478,400. The operating expenses, including interest and sinking fund charges, are given as $124,940 per year for the two units, or at a rate of $1.11 per ton of refuse handled.

Project B.—Project B, for two 195-ton incinerators, is similar to project A, except that the garbage and rubbish are to be collected separately and sorted over to recover salable material. Only a portion of the ashes would be delivered at the incinerators, the remainder being used for filling. The estimated average daily weights to be handled in project B are somewhat less than in project A. For 600,000 population there would be 200 tons of garbage, 67 tons of rubbish, and 68 tons of ashes daily, a total of 335 tons. It is assumed that two-thirds of the total rubbish collected would be burned, the other one-third being picked out and sold.

The estimated cost of constructing the two 195-ton incinerators, including means for picking out and handling the salable portions of the rubbish, is estimated at $489,300, with annual gross operating expenses of $166,570. In Buffalo, N.Y., the average receipts from the sale of material picked out from the rubbish for a period of over 4 years were $2.34 per ton of rubbish handled; on the basis of $2.25 per ton for Toronto the sale of the picked material will yield an income of $67,300 per year, thus giving a net annual cost of operation of $99,070, or 89.9 cents per ton of refuse handled. By comparing the operating cost of projects A and B it is seen that the picking out of the salable parts of the rubbish will result in an estimated annual saving of $25,870.

Project C.—In this project it is proposed that the garbage, rubbish, and ashes be collected separately; that the garbage be disposed of by the reduction process (grease and tankage being recovered); that all of the rubbish be incinerated; and that all of the ashes be removed to dumps and used for reclaiming low land. The average daily amounts to be disposed of, under this project, with a population of $600,000 are: Garbage, 200 tons; rubbish, 100 tons; ashes, 800 tons; total, 1,100 tons.

Project C provides for two 60-ton rubbish incinerators within the city limits and a garbage reduction works located about 10 miles east of the city near the shore of Lake Ontario. At each incinerator site it is proposed to install a loading-station with a railroad siding extending through it. Garbage wagons would be driven into the building and their loads dumped into special steel railroad cars of 40 tons capacity each, the car-body to be semi-circular and set on trunnions to facilitate the discharge of its load at the reduction works.

The reduction works would have a capacity of 240 tons per 24 hours and would comprise an unloading building, conveyor, digester building, containing digesters and presses for the cooked material, a dryer building where the moisture from the pressed tankage would be driven off, and a percolating building in which grease would be extracted from the dry tankage by means of the naphtha process. The liquids removed from the digester building would go to a grease separating and evaporating building. The syrup resulting from the evaporation of the liquids remaining after the grease had been drawn off would be mixed with the percolated tankage and dried, after which the tankage would be ready for shipment. It is proposed to operate all of the equipment at the reduction works power-plant by electricity, purchased from the Hydro-Electric Commission.

The estimated cost of constructing the two 60-ton rubbish incinerators, without means for picking out the salable material, is $227,700, including land. The operating charges for the two units, based on a population of 600,000, is $47,180, or at the rate of $1.573 per ton of rubbish handled.

The garbage reduction works, including loading stations, railroad sidings, power-line, etc., will cost $538,200 and the gross annual cost of operation of 600,000, will be $169,970.

In estimating the receipts from the reduction works at Toronto it is assumed that, with the naphtha process, the amount of grease recovered would be 3.5 per cent. and the dry tankage 15 per cent. of the weight of the garbage reduced and that grease would bring 3.5 cents per pound and tankage $7 per ton. On this basis the receipts from the sale of grease and tankage would be $210,000 per year giving a total net income of $40,030 annually, or 66.6 cents per ton of garbage.

Combining the estimates for the two incinerators and the reduction works, the construction costs for project C are $765,900 and the operating expenses $7,150 per year.

Project D.—This project is similar to project C except that the salable parts of the rubbish would be picked out and sold. The garbage, rubbish and ashes would be collected separately. The estimated daily average weights to be dealt with are garbage 200 tons, rubbish 100 tons, ashes 800 tons, the latter to be used entirely for fill. Of the total weight of rubbish only 67 tons would be burned in incinerators each day, the remainder being picked out and sold. Two 40-ton rubbish incinerators and one 240-ton reduction plant are recommended. The works are all practically a duplication of those described under project C.

The estimated cost of constructing the two 40-ton rubbish incinerators, including means for sorting out and handling

the salable part of the rubbish and including land, railroad sidings and paving is $2,555,300. The gross annual operating costs, including fixed charges and the cost of picking over the rubbish, is estimated at $92,510. The receipts from the salable material recovered, based on a value of $2.25 per ton of rubbish handled, would be $67,500 yearly, reducing the net cost of operation to $25,010 per year, or 83.4 cents per ton of rubbish handled.

The garbage reduction works and accessories are estimated at $538,200 for construction, and $169,970 gross for operation, the same as in project C. The estimated annual income from the sale of grease and tankage, however, is $210,000, leaving a net annual income of $40,030 for the reduction works.

Combining these estimates for the incinerators and reduction works the total cost for project C is $793,500 for construction, and with a population of 600,000 it is believed that there will be a net annual income of $15,020.

Summary.—After a discussion of the relative merits of the four projects Messrs. Hering & Gregory recommended that the refuse be separated into three parts, to be collected separately, that the garbage be taken to a reduction plant, located east of the city and converted into salable products, the rubbish to be taken to incinerators within the city and there burned, either without or with picking. It is also recommended that the ashes be taken to points within the city where land-making or road foundations are desired.

The report enumerates the important factors which lead to the final recommendations regarding the refuse disposal problem at Toronto. The first point has to do with the low-cost electric power from Niagara Falls. When the investigation was started it was the opinion, both of the local authorities and of Dr. Hering, that incineration of the city refuse would be the most probable solution and that works for this purpose would be required. With the advent of cheap hydro-electric power in Toronto the usual revenue to be expected from the sale of steam produced at incinerator plants can not be counted upon to reduce operating expenses. It would be cheaper at Toronto to allow the heat generated at incinerators to be wasted and to buy power from the hydro-electric company than to pay the cost of converting the heat into power. In view of these unusual local conditions the reduction process of garbage disposal comes prominently into the commercial foreground. The results obtained by the reduction process at Cleveland and Columbus are regarded as evidence of the satisfactory results obtainable from such works when properly operated.

The second important point bearing upon the recommendations is that the disposal of garbage, rubbish and ashes only is considered; other refuse, such as street sweepings, dead animals, etc., is disposed of satisfactorily by present methods.

The third consideration concerns the combined or mixed collection of refuse. The reduction process demands a separate collection of the several classes of refuse, and this is more costly than combined collection. The report advocates an investigation into the possible economies of collecting the refuse by electrically-propelled wagons receiving power from storage batteries.

The treatment of the refuse after delivery was the fourth important point. From the preceding figures of cost it is apparent that the projects for reducing the garbage and incinerating rubbish require a much greater outlay for construction than the projects for incineration of garbage, rubbish and ashes; the increase is $287,500 more without equipment for picking and $304,200 more with such equipment. The operating costs for the reduction projects, however, due to the return from the sale of products, is very much less, the difference being $117,790 per year without picking and $114,090 per year with pickings, assuming the population to be 600,000. Looking at the problem from the financial side, which it was the main object of the report to deal with, it appears that the reduction of the garbage is the most desirable means of disposal, although the necessity for separating the refuse is bound to cause inconvenience to the householder which a mixed collection would avoid.

WASTEFUL SYSTEMS OF SEWAGE PURIFICATION.

In a paper read before the Manchester Section of the Society of Chemical Industry, Dr. Grossmann stated that if all the valuable manurial constituents which are contained in sewage could be utilized on the land they would represent a value of somewhere about $200,000,000 a year. When the present system of sewage disposal by water carriage was adopted it was pointed out that it was the most wasteful system on economic grounds, but it was recognized that its advantages from a hygienic point of view should be such as to outweigh commercial considerations. The sewage, which is conducted by underground sewers to the sewage works to undergo further purification, consists of a liquid and a solid part, which are separated at the sewage works, and so far as the liquid part of the sewage (which ultimately finds its way into the rivers and the sea) is concerned, the present mode of purification, if properly carried out, will fulfil all anticipations with regard to public health; but as regards the solid part, the present mode of disposal is still a danger to the community. If that part which is generally termed "sludge" is carried out to sea there is a danger of infection to oysters, shell-fish, and fish; there is, moreover, a chance of this filthy material being washed back to places on the coast, as has been the case at several seaside places. If dumped on the ground it creates a nuisance, and if used on land for farming purposes there is the danger of infectious diseases being communicated to cattle and human beings from grass and crops grown on such land. Experiments carried out by the most eminent agriculturalists at the instigation of the Royal Commission on the treating of sewage and sewage sludge have conclusively proved that the value of sewage sludge, calculated on the dry substance which is contained in it, is no more than 10s. per ton at the outside, and as the sludge is produced at the sewage works in a state containing a large amount of water is cannot pay the farmers to use it unless the farms are in such close proximity to the sewage works that the cost of carriage and cartage is inconsiderable. Attempts have been made to reduce the cost of carriage by drying the sludge, but even after drying in the ordinary way it cannot be considered to be effectively sterilized, and is therefore still liable to carry infection. Moreover, it has been proved by the Royal Commission that it is worth even less after drying than before.

Dr. Grossmann gave calculations which showed the futility of attempting to dispose of the sludge by gasifying it in producers or of obtaining illuminating gas from it. The conclusions that he arrives at are that until the disposal of sludge is effected by sound hygienic methods there is still danger to the community; that no process for the disposal of sewage sludge can be considered satisfactory which does not enable us to return the manurial constituents contained in it to the soil in a thoroughly sterilized condition, and that sludge can never become a valuable manure unless it is previously freed from the greasy matters arising from soap suds and other fatty substances which in the sewers become mixed with the sludge, and which prevent its manurial constituents from being assimilated by the plants.

THE ECONOMIC ORGANIZATION AND MAINTENANCE OF THE FREIGHT CAR REPAIR YARD AT A TERMINAL POINT.*

By J. Thos. Warde.†

The question of the proper maintaining of a repair plant of where there is from two hundred to two hundred and fifty cars repaired daily, is a very serious one, and calls for careful consideration, to not only handle the work expeditiously but also to handle it in an economic manner.

To take the yard itself: Its location must be carefully selected; when possible, select a position where you can have twelve tracks of a capacity of twenty-five to thirty cars; tracks must be at least sixteen feet apart, alternate tracks, have a supply track of standard gauge and a third rail to form narrow gauge, and each end of yard should be connected by a lead. Yard must be well drained and, if possible, equipped with sewer and water system, compressed air system, electric power and light, and yard should also be in the near vicinity of shops as possible.

For buildings would recommend a central building under one roof, accessable from all parts of the yard, consisting of the foreman's office, general office, time office, stores, carpenters' shop, paint shop, oil house, triple rack, blacksmith and machine shop, men's lunch room and toilet, also lumber racks, material platforms and racks, and wheel tracks for B.O. and serviceable wheels. The advantage of one building lays in the fact of one heating; this can be very economically arranged for by an old boiler, and fed by the scrap wood, etc., this overcoming to a great extent the danger of fire, account of having stoves.

By having a drive-over about the centre of the yard and a standard gauge track, with a third rail making a narrow gauge track with turn-tables at intersects, you can connect all supply tracks—this can be used for handling wheels as well as other material, and also as a means of keeping yard clean of scrap, etc.

The fact of supplying a repair yard with a sufficient supply of necessary tools, quick lifting jacks, etc., and machinery should not be lost sight of, as (supposing yard is equipped and wired for electricity) individual electric motor power is not only economical, but desirable for the running of machinery. It will be found economy to install cut-off and rip saw, band saw, buzz planer, little giant borers, drills, portable forges and riveting hammers for steel car repairs, with a capable man in charge and helpers, blacksmith's forges with electric power fans.

Oil house should have (underground if possible) tanks. This point should have air device for emptying of oil barrels; should contain waste bin, oil tanks for soaking and proper treatment of, and making of dope.

Paint room should have a galvanized-iron covered table for cleaning of stencils, rack for storing stencils, iron tanks for paint, oil, etc.

The store room should be fitted with drawers, pigeonholes, racks, etc., for the proper storing of material and small supplies.

General office for use of assistant foreman, inspectors, clerks, etc., with a private office for foreman in charge. The efficiency of the organization depends on the executive and personal individuality of the foreman in charge; he should be a man of ability, an energetic nature and resourceful. His staff should average, for the number of cars mentioned: Six assistant foremen on a monthly salary, one inspector, four car oilers, thirty freight carpenters, one hundred and seventy car repairers, thirty laborers, two painters, two assistant painters, one clerk, two boys, one storeman, one leading laborer, two checkers, one leading air cleaner and tester, eight cleaners and two testers, and one pipe man and helper. The duties of the assistant foreman should be to oversee the work, under the general supervision of the foreman; these men should be taken from the rank and fyle, who have proved themselves adapted to the general overseeing of men and work; they should be practical and thoroughly conversant with the details of their work. The duties of the car inspector consists of inspecting all cars leaving yard; this man must be thoroughly conversant with the M.C.B. rules. Records of all foreign cars should be kept, re repairs. Repair and defect cards must be made and affixed according to M.C.B. rules. Duties of leading air brake tester: This man should have charge of air brake cleaner, testers and pipeman, and should be responsible, under the car inspector, for all air brake work. All triples should be cleaned and tested at the triple-rack, and a stock kept on hand for replacement. Duties of car oilers: It would be policy, although not recommended for a yard of this size, to have a leading car oiler; his duty would be to see that all dope is properly made, and a supply always on hand; he should inspect all boxes, and advise the oiler as to the re-packing. I recommend, in the matter of re-packing journal boxes, that a proper system be organized, and boxes re-packed and stenciled, and in the event of six months elapsing, pull box and renew packing, or, in other words, renew the packing every six months; packing removed to be treated and the oil and waste reclaimed. Two car checkers should be able to take record of repairs made to cars; same should be reported to foreman and fyled. Cars handled should be recorded by index system, and would recommend that a system be adopted to show time placed, time O.K., and dates; this can be handled by one of the boys. Carpenters and car repairers should be placed with assistant foreman as necessary, but recommend that any assistant foreman have not more than forty men. Painters should have well in hand the work of painting, etc.; all sheeting, roofing, etc., should be painted ready for use; the advantage in this is manifold, you have always something to keep your painters busy, your sheeting for patching is ready for the stencil, and finally your car is O.K.'d in one day instead of three. Laborers should be under charge of a leading-hand; his duties are manifold, from seeing that the scrap, etc., is gathered and placed in proper receptables to seeing material placed at stores, also heavy material placed in a convenient position to handle. The storeman should have charge of supplies, and be directly responsible for their up-keep. The foreman should furnish the general storekeeper every day a list of material supplied, attaching requisitions received and furnish a list of requirements. Foreman should be in close touch with stores and be in a position to anticipate requirements; this would be of mutual benefit both to storekeeper and himself. The clerk: I prefer training a man from the ranks of car repairers, as, being familiar with the work, he can handle the position to advantage. The foreman should insist on a careful record being kept of all work, supplies and general conditions, as the work of wrecking naturally falls to the repair yard, it is up to the foreman to insist on maintaining an efficient staff, and the wrecking crew should not be less than twenty men, taken from the car repairers; from these men selected at least two of them should be first aid men, holding certificates, and who have become conversant with the work; the men should be selected as required, according to nature of wreck; they should be under the charge of an assistant foreman, this man

*Paper delivered to Western Canada Railway Club, Winnipeg, Dec. 11th, 1911.

†Chief Clerk to General Car Foreman, Canadian Pacific Railway Co., Winnipeg.

should also be held directly responsible for everything in connection with wrecking work and the proper up-keep of the auxiliary equipment, and himself and crew be available day or night. One man should be assigned to the duty of factotum of the dining and sleeping car, and be able to satisfy the inner-man; his duties would also be that of commissary, which is no small part of the wrecking equipment.

The auxiliary equipment should consist of a serviceable dining and sleeping car (an old coach makes a good car) for this purpose, a tool car, heavy wrecking steam crane, block, tie and rail car, truck and wheel car. Tool car should be equipped with a first aid cabinet complete, with supplies and a modern equipment, quick lifting, traversing and other jacks, a plentiful supply of cables, tail ropes, chains and tools, and one man should be held responsible for their proper up-keep.

In arranging work for efficient handling on the repair tracks a set of rules governing proper marking of cars by inspectors in the traffic yards would aid repair yard men, and the rules of marking of cars should be respected by switchmen in placing cars on the repair tracks. Defects should be classed in A, B and C, or 1, 2 and 3 classes. Heavy work (three days) such as sills, roofs, etc., show A or "1" class; sill splices, ends, draught timbers, trucks, etc., medium work (two days) as class B or "2"; light, such as light patching, draught timber and gear bolts, brakes, side doors or any light work that can be handled in one day, show class C or "3." Tracks should be designated by the symbol or figure and cars placed as marked.

The foreman should place with yardmaster a switch list showing cars O.K. and location, listing cars he requires changed to other tracks to arrange his repairs, but the whole secret of success lies in co-operation with operating department in providing a proper and efficient system of switching.

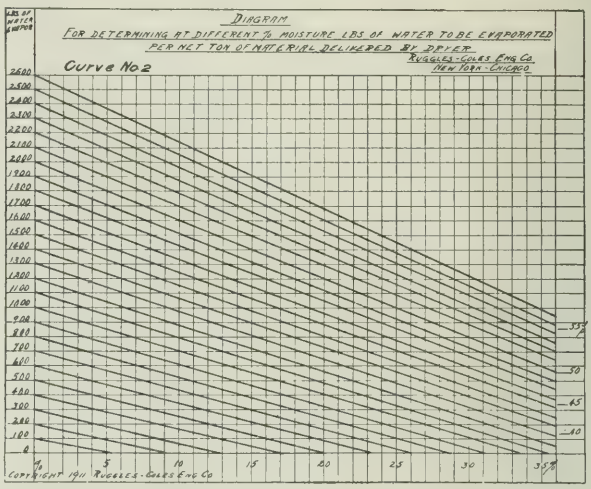
THE IMPORTANCE OF PERSONALLY STUDYING MIXER SPEED.

A great many contractors take the word of the operating engineer of the mixing plant as to results derived by increasing or decreasing the speed of the mixer drum, while for some unaccountable reason the latter seem unable to grasp the fundamental principles underlying the operation of a mixer for maximum capacity. A personal investigation by the contractor will often pay, as evidenced by the experience of Mr. A. W. Ransome, the well-known manufacturer of concrete mixers, who in a recent discussion stated that he visited a plant in which one of their 1-yd. mixers was being driven at eleven revolutions, and it required, at this speed, something over a minute and a half to discharge the bath. By speeding up to 19 r.p.m. the batch was discharged in less than 15 seconds.

Mr. Ransome stated that their machines are ordinarily sent out with the engine adjusted to give a mixer speed running from 16 to 20 r.p.m., depending on the size of the mixer involved. The speed for which the various machines are adjusted is that which will give the best results for the average material. The speed, however, is more or less subject to variation, according as the materials to be mixed vary and as the amount of water used in the mixing may vary. In other words, if the material flows very freely, the speed of the drum should be higher than if the material flows less readily, and, similarly, where a very wet mixture is used, the drum should be driven at higer speed than where the drier and more sticky mixture is handled. The real governing factor is to be found by looking in the drum opening and so adjusting the mixer speed as to get the maximum discharge into the discharge chute, instead of falling short thereof, or carrying over.

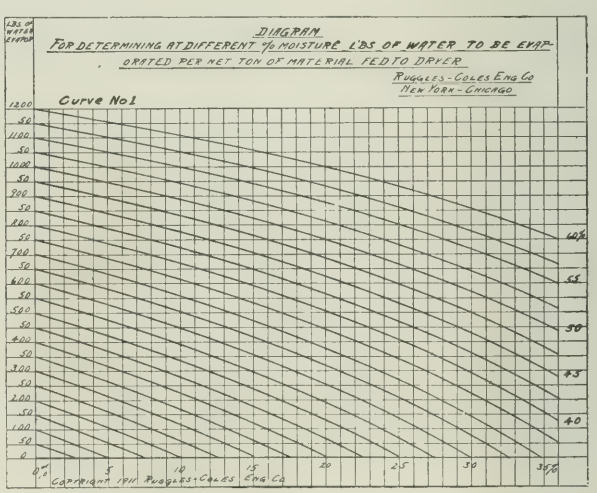
USEFUL CURVES IN DRYING CEMENT ROCK, CLAY, AND SIMILAR MATERIALS.

Cement companies use dryers for treating cement rock, clay, and other argillaceous materials as well as for drying the coal so that it may be pulverized and made ready for the kilns. The amount of water to be evaporated in reducing a given ton of material from one percentage of moisture to another is often desired to be known quickly. The curves



prepared by the engineering staff of the Ruggles-Coles Engineering Company fill this need and are reproduced here.

To make the use of these curves clear take a specific case of reducing cement rock from 6 per cent. moisture to 1 per cent. Referring to curve No. 2 follow the diagonal opposite to 6 per cent. at the bottom until it intersects the ordinate of 1 per cent. Then follow across to left and the figure 140 lbs. is the amount of water to be evaporated per



net ton of the cement rock delivered by dryer. Curve No. 1 is used in the same way and from it can be determined the lbs. of water to be evaporated per net ton of material fed to dryer.

A considerable saving of time can be effected by the use of these curves, and the Ruggles-Coles Engineering Co., 50 Church Street, New York, will send blue prints of them on request.

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THE TORONTO HYDRO-ELECTRIC COMMISSION.

The method of handling departments of municipal utilities by means of a commission has, during the past few years, received comment, both favorable and otherwise. There is little doubt that a commission composed of capable, energetic men is a most excellent instrument for directing and supervising the manifold items incidental to the carrying on of large undertakings. If a commission, however, is not well balanced and composed of individuals who have the time necessary to follow closely the daily routine, adjusting as occasion requires the small daily troubles that arise, and infusing into the work of the subordinates new vitality and enthusiasm, the work of such commission will not be the most efficient. Efficiency in these days of hurry is a prime requisite. The outlays of capital used in large constructional undertakings demand that work should be expedited as quickly as is consistent with a due regard for good construction, in order that interest charges may not accumulate, and that the period of income may quickly arrive.

The Toronto Hydro-Electric Commission was formed by act of the Ontario Provincial Legislature, and is composed of three men, one appointed by the Hydro-Electric Commission of Ontario, one by the city of Toronto, and the third the mayor of Toronto ex-officio. The work laid out for this commission is a large one, and it has only begun. Before it is finished there will have been a total expenditure of four and a half millions, of which only two millions have been already used. As we have noted in these columns before, the Toronto Hydro-Electric System has a strong competitor in the Toronto Electric Light Company. This company, with its affiliated interests, has the control of a large generating plant of its own at Niagara Falls, and it has its own transmission system. Its present heavy contracts with the Toronto Street Railway and other companies, place it in an enviable position for a strenuous fight. Every day the Toronto Electric Light Company is taking on new business which the Hydro-Electric, if it were in a better and more advanced position, could handle. Every contract the Hydro-Electric loses means a lengthening of the time before the system will be on a paying basis, which time must come before there is a lowering of rates.

The mayor is too busy a man to be saddled with the duties incidental to the work of the commission. Who would ask that the mayor be a member of the Harbor Commission or of the York County Good Roads Commission? Yet the duties of this body are far more onerous than either the Harbor or the Good Roads Commission. The mayor's duties are too many and too varied to force him to act on this body. Mayor Geary would be justified under the circumstances in withdrawing from the commission and appointing another who will devote his whole time to the work. By an amendment to the Act this could easily be done. Mayor Geary has proved himself in the past to be too broad and big a man to stand in the way of efficiency in the handling of the city's work, and we feel sure that sooner or later he will come to the conclusion that the interests of the city will be best served by an amendment to the Act as it now stands.

THE IMPORTANCE OF KNOWING COSTS.

The engineer of the present, to give the maximum of efficiency to his clients for expenditures on new work, must have a thorough knowledge, not only of the theoretic part of the design, but also of the methods of con-

struction necessary to give the minimum of cost. At the annual dinner of the Faculty of Applied Science and Engineering of the University of Toronto, on January 18th, Mr. W. F. Fye, the president-elect of the Canadian Society of Civil Engineers, laid special emphasis on the knowledge of costs in the experience of the engineer. Mr. Fye said that, to his mind, the most apt definition of engineering is "the art of doing well with one dollar what any person can do with two," and that it was impossible to do this without an intimate knowledge of costs and cost analysis. He would, therefore, advise the young engineer to keep records of the cost of the different works on which they are employed.

There is no question that this branch of the work of the engineer is exceedingly important, much more important than appears to be appreciated by many of the profession. Too often the question of costs is left entirely to the contractor who has the construction and installation of the work. But the engineer who superintends and lays out the work is negligent in his duty to his employer, and to his own best interests, if he does not keep in close touch with the costs of the different elements of the work. Much more necessary is it for him to have such knowledge if the consruction is being done by himself for his employer. For it is only by obtaining full information regarding costs that he can supervise intelligently. By a slight change in the method of arranging forms for concrete, by a different location for the concrete mixer, or in a hundred and one different ways he will find that he can save money and reduce the cost. There is another indirect effect which this study of costs has. The engineer who has constantly before him the aim of obtaining the most efficient results will not be led to needless outlay in the matter of design. He will study each element of the design in its relation to the purpose it must serve, and will choose the material which will do this as cheaply as possible.

The above statement is not intended as a plea for cheapess at the expense of efficiency or durability, but rather as a warning against the use of expensive and unnecessary details.

PER CAPITA ASSESSMENT.

The following table, which has been compiled by Mr. Samuel Baker, the city clerk of London, Ontario, presents in a clear manner the present standing of the ten largest cities in Ontario, as regards per capita assessment. It will be noted that the debenture debt per capita fluctuates within a wide range, from the figure of $45.93 for Windsor to the figure $182.98 for Fort William, although there is little difference in the population.

Per Capita Assessment.

City.	Population, 1911.	Municipal Taxes.	School Taxes.	Debenture Debt.
Toronto	341,991	$11.77	$4.59	$111.02
Ottawa	86,106	11.06	5.34	96.57
Hamilton	73,542	8.89	3.59	79.60
London	46,727	10.35	4.70	80.48
Brantford	21,964	10.05	3.73	90.17
Fort William .	19,858	12.44	5.75	182.98
Kingston	18,914	7.24	2.49	65.22
Windsor	17,534	10.16	4.63	45.93
Peterboro' ...	16,923	7.55	4.91	83.04
St. Thomas ...	15,240	7.77	3.52	61.78

One of the significant points of the table is the fact that Toronto, with the largest population, has also by far the largest debenture debt per capita, with the exception of Fort William. Evidently the citizens of Toronto showed good judgment in turning down the Tube by-law in the last municipal election.

Hamilton is to be congratulated on its showing as compared with the other cities of large population. When consideration is made of the large increase in population and area there in a comparatively short space of time, it reflects great credit on the city administration that they have been able to keep their debenture debt down.

EDITORIAL COMMENT.

In a recent newspaper report we note that Dr. McCullough, the Provincial Medical Health Officer for Ontario, has been on a tour of observation with Mr. N. J. Kerr, city engineer of Ottawa, looking over the different water filtration and sewage disposal plants of the United States preparatory to the installation of systems in Ottawa. If this is true it would appear that the Medical Health Officer is going afar afield of his duties. The plans which will be prepared for this work will, in the regular course of events, return to Dr. McCullough for acceptance before installation. He will then be put in the peculiar position of passing judgment on a scheme or design which he has already tacitly accepted while consulting with the city engineer. Ottawa may thus save the cost of paying for the services of a consulting engineer, but we do not believe that this means of doing so will meet with the approval of the engineering profession or of the public at large.

* * * *

Sir Hugh Allan, chairman of the Allan line, states that while he is very fearful of the practicability of a Canadian Lloyds, he would welcome it heartily. He believes, like many other Canadian shipowners, that the St. Lawrence route has been charged with many casualities which might fairly have been spread over other sections of the North Atlantic, and consequently the St. Lawrence vessels have been required to pay more than their full share. At the same time the rates of the English association has been on the whole both carefully and fairly made up. Mr. F. W. Cowie, the chief engineer of the Montreal harbor, states in an article published last week in The Canadian Engineer that during the season just closed only one marine accident of any importance happened in the St. Lawrence ship channel, when a large freight ship grounded and was released by tugs after lightening part of the cargo. This is certainly an enviable record.

LETTERS TO THE EDITOR.

The Editor:

Sir,—On about the fifteenth of October of last year, the building inspector of the city of Saskatoon ordered work stopped on two buildings known as the Willoughby and the Willoughby-Sumner blocks, on the grounds that the reinforced concrete structure was not sufficiently strong, for some unstated reason, either workmanship, materials or design. Work was suspended for about three weeks and then resumed on account of the building inspector having withdrawn his objection. In the meantime the report spread that the buildings were unsafe, and the writer, who happened to be away at the time,

heard of it in Winnipeg and St. Paul. The work was in charge of the Forest City Paving & Construction Co., and the architect W. W. LaChance, Esq., of Saskatoon. The reinforced concrete was designed by the writer, using twisted and round bars and following the specifications of the American Society of Civil Engineers. When the writer returned to Saskatoon he found that B. V. Hole, Esq., general manager of our company, had secured the services of W. R. Harris, C.E., M. Am. Soc. C.E , to superintend the making of tests on the buildings and that tests had already been made on the Willoughby building, and that same had proved satisfactory. Soon after, tests were also made on the Willoughby-Sumner building, which also proved satisfactory, and we enclose herewith a copy of the report by W. R. Harris, C.E., on these tests.

I might say that I am sending this letter to you at the suggestion of Geo. H. Archibald, Esq., contractor, Winnipeg, he having called the writer's attention to the fact that the reports circulated regarding these buildings had injured the standing of reinforced concrete construction in Western Canada, and that it was in the interest of the trade in general that a satisfactory explanation be made. The writer agrees with Mr. Archibald in this, and hopes you may see fiit to give this letter the publicity it may deserve. Yours very truly,

E. W. HYDE, JR.,

Manager Saskatoon Branch Forest City Paving & Construction Co.

Forest City Paving & Construction Co., Saskatoon, Sask.

Gentlemen,—I desire to report as follows, regarding examination and tests of two concrete buildings being constructed by you in this city:

On October 31st I examined the concrete and supervised the test loading of beams and floor slabs in the Willoughby building and found the concrete hard and sound.

Floor slabs and beams were subjected to a test load equal to 2½ times the estimated safe live load of 70 pounds per square foot, with a maximum deflection of ⅛ inch.

The deflection was normal and the examination and tests indicate that the structure is fully capable of serving the pupose for which it was designed and constructed.

On November 3rd the Willoughby-Sumner building was examined and tested, and in general the concrete was found to be hard and sound.

It was apparent that the concrete in this building was gaining additional strength with age, as is to be expected of concrete properly made.

All floor slabs and beams tested, except one, showed a normal deflection of ⅛ inch.

The one exception was a beam through which four electric conduits passed, the deflection on this beam was ¼ inch with a development of small cracks in tension side of beam.

This beam was not tested to destruction nor was permanent injury caused same by the test.

This building is capable of carrying the loads for which it was designed.

The first, second and third floors of the Willoughby building and the first and second floors of the Willoughby-Sumner building were tested; the remainder of the floors were not tested because a sufficient time had not elapsed since the floors were poured to justify such a severe test loading. Yours very truly,

(Sgd.) W. R. HARRIS, Saskatoon, Sask.

CANADA'S TRANSPORTATION PROBLEM.

BY E. B. BIGGAR.

Re-examining our economic relations to our fellow men and to the state, we find that out of what we produce —whether we are farmers, artisans, merchants or manufacturers—we pay toll or taxes mainly in two forms; first, on what we send out or take in from one place to another within our own country, and second, on what we import from other countries. The first we speak of as transportation charges, the second as customs duties. If we were born and educated in the planet Mars and dropped down upon the earth to investigate things anew, we would wonder why the second class of tolls upon our labor and income, though of minor consequence, is regarded as of the greatest political importance, while that which concerns each one of us most nearly, since it is an impost on everything we sell as well as everything we buy, is considered by many to be a matter almost outside the domain of politics. The readjustment of the customs tariff on an item that may add one dollar to the cost of a suit of clothes is a subject of such contention as may decide the fate of a government, but a railway official may, by a whim, or to meet an exigency, revise a schedule of rates which will add hundreds or thousands of dollars to the cost of our business, and the change seems to be accepted as a decree of fate.

Years before confederation became a practical issue in British America, a transcontinental railway under state control or ownership was advocated as a means of welding together the scattered groups of British colonies throughout the world, and so long ago as 1847 the prophetic vision of Major Carmichael Smyth saw in such a continental railway "a great link required to unite in one powerful chain the whole English race." There is the clearest proof that the need of a government owned transcontinental railway, both for imperial political purposes and for economic reasons, was felt long before there was a conviction in all the provinces that confederation itself was required. Antagonism to the confederation on political grounds lingered in some quarters long after the Act of Union came into force; while the warmest advocates of the measure found it necessary to acknowledge in a formal way in the terms of the union that, "the construction of the Intercolonial Railway is essential to the consolidation of the union of British North America and to the assent thereto of Nova Scotia and New Brunswick."

The Intercolonial Railway, however serviceable for local purposes, has always stopped short of that point where it could give to all the provinces the benefit of the lowest rates and best service from prairie to Canadian seaboard. For a time it ended at Riviere du Loup, then after a long delay at Quebec, and a still longer time elapsed before it reached Montreal; and all this time the railway traffic of Quebec and Ontario, and later on that of the new prairie regions, found its way to the sea, largely by way of Portland, Boston and other United States ports, instead of through the ports of the Maritime Provinces, which had paid for it by their assent to the union.

The high rates charged under the private ownership and control of the Canadian Pacific Railway have operated as a handicap alike upon the people of the West, and upon the fishermen, farmers, manufacturers and merchants of the Maritime Provinces—the former because prices have been depressed and the latter because the excessive tax of transportation cuts them off in competition with the producers and manufacturers of the middle western states, who ship to Canada at a cheaper rate. The same handicap operates against Ontario and Quebec.

Recent investigations of freight rates, passenger rates, express rates and telegraph rates, show that the cost of

transportation in the Canadian West is in excess of rates for corresponding distances in the United States by proportions ranging from ten per cent. to over one hundred per cent. This being the case, of what avail is it to the people of Canada to assist in building a second and a third transcontinental railway when there is no reduction of rates?

The Conservative government, which created the Canadian Pacific Railway, may have thought it provided a safeguard for the return of some of the enormous assets which it threw into the company's lap in money and lands when it stipulated that all profits in excess of ten per cent. should be returned to the people. But the company has found a way to mop up these extra profits by the creation of subsidiary companies, such as hotel companies, catering companies, land irrigation companies, etc.

To make a bad situation worse for the people who pay without control, the late Liberal government in subsidizing the second transcontinental system committed the people to an expenditure which it is said will reach $250,000,000, and has designed as far as it could, that that portion of the new system, which is owned by the private corporation and comprises the only profitable part of the road, should be exempt from the control of the government railway commission, while the portion in which there is no present possibility of profit is owned by the government and controlled by the commission.

It is true that there is a proviso in the Grand Trunk Pacific Act that the company shall not charge any higher rates to a Canadian sea port terminal than to a terminal in the United States. But to those who know the methods by which the Grand Trunk secures its present traffic from the West to its own terminal at Portland, and who know the plans now being matured at great expense for a second United States terminal at Providence, R.I., this provision will only give a light touch of comedy to the administrative tragedy of the late government. The appropriation of $30,000,000 to the Canadian Northern for its transcontinental road passed in the late Parliament almost without comment from either side, as the cold potato was handed to Rip Van Winkle.

Here we have government railways built at a cost to date of over $237,000,000, carefully held back from reaching the only regions of the country where promising traffic exists destined for the sea; while privately-owned railway corporations to which the Dominion and provincial governments and municipalities have given cash bonuses amounting to over $301,000,000, besides vastly more valuable lands, are levying upon the producers of the West a form of internal revenue tax which no people could possibly pay if it were not for the miraculous fertility of a virgin soil. Remembering that the Canadian railway companies are also the owners or controllers of the express and telegraph companies of the country, it is within the bounds of truth to say that these imposts when combined make a system of taxation upon the people unparalleled in any country pretending to modern civilization.

Seeing that the world's market prices are not fixed in Canada, foreign trade can only be gained by reducing the cost of transporting the products of the mid-continent to the Atlantic and Pacific. The control of rates, and ultimately the ownership of the transcontinental lines of communication, is the only means to this end, because the purpose of private ownership is to make profits out of its transport system, while government ownership, with the object of international trade would seek to render an efficient service at the lowest possible cost consistent with the payment of good wages. The excessive rates are undoubtedly the prime cause of the apparent difference in prices in favor of United States goods as compared with Canadian goods when laid down in the Canadian West.

Essentially the transportation of human beings and the materials of their sustenance and employment is of the same nature as the transmission of intelligence through the post, and as no statesman would now propose to hand back the postal service of a nation to private operators as once was the case, so the day is fast coming when the railway service of Canada must be under state operation.

The solution of the problem therefore is to prepare for the acquisition of the railway, express, telegraph, and long-distance telephone services, and as a preparatory step, to bring these present public service corporations under the authority of the railway commission which can be reorganized into branches to cope with its increased work. It may be that the railway companies will have the foresight to see that these changes must come, and the wisdom to accede in advance to a change to which they must otherwise yield under pressure of public opinion. Such a yielding is in fact now advocated by some of the ablest railway managers in the United States who recognize that the logic of the increasing control now exercised by the government over railway corporations is early government ownership.

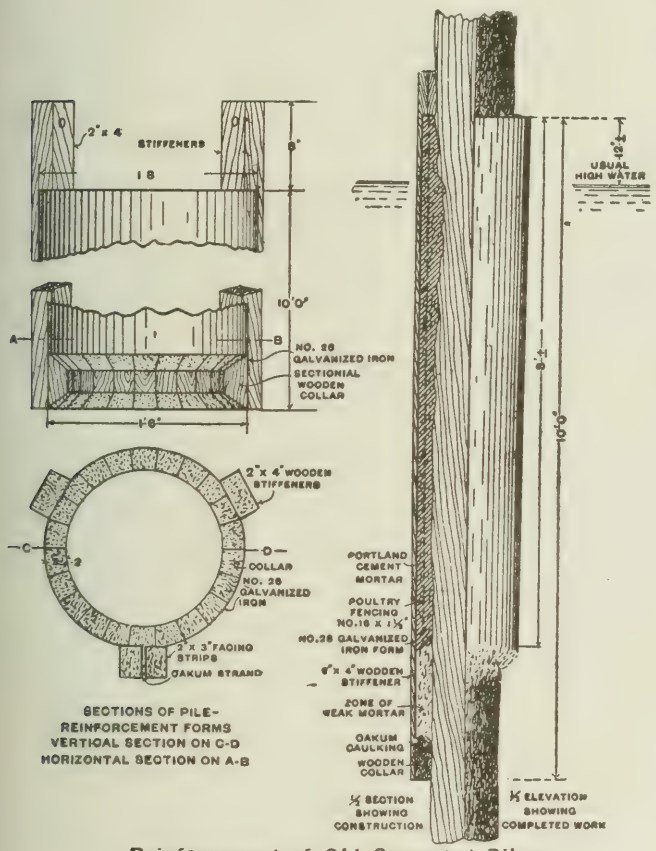
The Grand Trunk Pacific Railway should be expropriated by the Dominion government, and joined to the Intercolonial Railway, so as at once to afford an automatic regulator of rates from prairie to sea. That or the extension of the Intercolonial Railway to the Pacific. Some such method seems the only practical way of rendering long deferred justice to the people of the Maritime Provinces, the Western Provinces and British Columbia, and of securing to the nation what will inevitably be lost under the present scheme—the shipment by Canadian vessels and from Canadian sea ports of the produce of Canadian soil.

But where Canada has suffered and will suffer yet more in yielding up the principle of railway development on which our confederation was founded, is in the enormous and unreasoning waste of money, labor and land in the triplication of lines where communications already exist, to the starvation of those parts of the country that are without railway facilities. There is not even the consolation that a second or third line effects a material reduction in rates. For example, three competing lines of the three great corporations are now being finished between Toronto and Montreal, where one with new tracks to cope with increasing traffic would serve the public. The city terminal costs alone run into millions of dollars, not to consider the permanent waste of land by the extra right-of-way and the waste of labor by the triplication of the staffs. In the end the people, whose produce, labor and earnings provide this traffic—and who consequently suffer for this waste—are not benefited in the slightest by this illusory competition. What does the word "competition" signify when there is no reduction of rates?

But this is not the worst aspect of this senseless waste of a nation's resources. What was the purpose of the great sacrifices made by the people in subsidizing the private corporations to build these chains of communication? Was it not to colonize our vacant lands and utilize to the utmost benefit of all the provinces the resources of the country? Without doubt. And yet the primary purpose of each of our private railway corporations is to string their lines where traffic already exists, and new territory is now opened up only where profits are immediately visible. If colonization and the utmost public service were the actual, as well as the theoretical motive of railway building in this country, we should have in the older provinces lines to thousands of villages that are yet without access to railways, and still paying the oppressive cost of wagon haulage; while in the great West we should have had twice the area of land under cultivation with a doubling of the productive capacity of the country.

PILE PROTECTION.

In a paper read before the Boston Society of Civil Engineers, which is printed in the Journal of the Association of Engineering Societies, T. Howard Barnes described some wharf construction for the Guatemala Railway Company in Puerto Barrios, Guatemala, in which it became necessary to deal with some creosoted southern United States piles which had been in place for about seventeen years. These piles were nearly all of them in fair condition, excepting at and near the water line, but at this belt for, say, 5 ft. in width, most of them were badly eaten, many having cavities extending completely through them, resulting from the combined activity of the teredo and the limnoria. The expense of replacing these piles with new ones would approximate $50 each. The incentive for saving them by placing some reinforcement was so great that the writer gave much time to its consideration.



Reinforcement of Old Creosoted Piles.

The first idea was to place such reinforcement by using a chamber clam-shell like, each half of which should have a semi-circular opening in the parting line of the bottom for embracing the pile when clamped about it, and which would admit a workman after unwatering the chamber, the annual space about the pile being first calked. A test chamber was made, but trials in controlling it against the effect of even a wind-chopped sea of moderate force proved the futility of rapid and economical manipulation, and the idea of working in the dry was abandoned. Had the apparatus proved successful it was proposed to place a reinforcement of nails, poultry netting and cement mortar, similar to that hereinafter described for protecting some of the piles which were placed in the new construction.

Accordingly, forms were prepared for placing in the wet about the old piles a reinforced cement-mortar envelope which should have a width of about 8 ft. and a minimum thickness of 2 in. These forms were made of No. 26 gauge galvanized iron shaped into cylindrical shape with a slight taper and 10 ft. in length. A 2-in. x 3 in. strip of pine having a length of 8 in. greater than the form was attached on each side of the parting line, which was up and down. The metal was folded about the strip 1 in. on to the 3-in. side, leaving 2 in. for attaching an oakum strand, which was needed to prevent egress of mortar. Two 2-in. x 4-in. stiffeners of same length as the facing strips were fastened to the form at one-third points as shown in the cut. A collar of 2-in. stock made from narrow blocks was provided at the foot to serve as a gauge for regulating the thickness of the mortar, as well as serving to calk against in closing the foot against the escape of the mortar.

The mortar envelope was reinforced by a wrapping of poultry fencing of No. 16 gauge with 1½-in. mesh. The procedure was, first to scrape off the mussel growth on the pile to be treated. This growth forms a complete mat, but is detached quite readily. The poultry fencing was then put in place. This was made up into a roll, 8 ft. long, with sufficient fullness to lap on to itself several inches when placed about the pile. The form, nearly buoyant with the stiffners, was then floated into place, first having been provided with a wreath of fluffy oakum affixed to the collar. The facing strips were closed tightly with carriage clamps hung from them by cords of such length that when the clamps were squared into horizontal position they were in the proper place for screwing up by the divers. The divers were naked, and their further duties were to close the bottom of the form effectually against the egress of the mortar, watching carefully that none escaped at the time of the filling. Steel bars 8 ft long of ½-in. stock were hung, one in each of the three sections of the form. They had a shepherd's crook for support on the top edge of the form, and were used for slushing the mortar into compact state as it fills.

The mortar was made, one part cement to about two parts sand, the latter being silica and selected as coarse as possible, say 0.18 mm. effective size. It was assured that there was a little overfill of cement. The operation of filling was carried on rapidly, the effect of the slushing rods being supplemented by tapping with clubs on the stiffners, resulting in securing a sound mass excepting in the lower zone of about 18 in.

It will be noted that the forms were made 2 ft. longer than the reinforcement cage. The separating of the sand from the cement in the lower portion could not be avoided under the limitation of having to drop the mortar through so great a depth of water; accordingly the reinforcement was made to occupy only the sound part of the envelope.

Fig. 2 shows the construction and the finished appearance of the work. At the time of writing, the work is still in progress, with a record showing no failures. It should, however, be added that at times much delay is caused by difficulty in sealing the foot of the form. It is useless to place the mortar when any is escaping at the bottom.

The expense of this treatment is—labor (contract price), $8; materials (cement, fencing, etc.), $4; a total of $12, to which should be added the expense of experimenting and overhead charges.

There seems good reason to expect a further life of the piles thus treated as great as that at present sustained.

URGENT DEMAND FROM THE ADMIRALTY.

A Birmingham, England, firm of engineers have received an urgent order from the Admiralty for 150 sets of torpedo firing gear. The Admiralty have decided in this instance to forego the usual electrical tests in order that the appliances may be delivered at once.

CONTRACTS FOR THE SUPPLY OF ELECTRIC POWER FROM THE USER'S POINT OF VIEW.

IV.

By H. E. M. Kensit, M.I.E.E.

Further important points that should be clearly defined are:—

At exactly what point the power is to be delivered, and, if any transformation is required, exactly where the power is to be measured.

The following are sample clauses on these points:—

(1). "The supply shall be delivered at the pole nearest the reducing station of the consumer, situated on the consumer's property at ..... All energy shall be deemed to have been furnished when the power company has maintained the supply at that point."

It will be seen that this defines the point at which the supply is to be given, and provides that the consumer is to supply, and, presumably, to equip, the reducing or transforming station. It also leaves the consumer to bear the loss in transformers for reducing the pressure.

(2). "The power company will construct a line to convey the agreed amount of power to the customer's premises ready for distribution at approximately the voltage and periodicity set forth above."

(3). "The electric energy to be supplied under this contract shall be delivered to the customer at the terminals of the main outgoing switches in the sub-station of the power company, and the electrical equipment in the said sub-station shall be daily inspected by the electrician of the customer, and he shall immediately notify the power company of any defect in the same or detail requiring attention. Such inspection by the customer's electrician shall be deemed to be a voluntary aid to the power company, involving no responsibility to the customer beyond the use of reasonable diligence in making the aforesaid inspection and reporting the condition."

Here the expression "main outgoing switches in the sub-station of the power company" defines that the power company are to provide sub-station and equipment and bear the loss in transportation.

(4). "The electric energy shall be 3 phase, 60 cycles, 2,200 volts, and shall be delivered by the power company at the customer's sub-station and measured at the primary 2,200-volt switchboard of the customer."

Here it is clear that the customer receives the power at 2,200 volts in his own sub-station with the intention of further reducing the pressure at his own expense.

In some cases the customers provide the sub-station building because this cannot be removed by the power company at the termination of the contract, and the power company provide all the equipment for the sub-station, this equipment remaining their property. This is a fair and usually satisfactory arrangement. It then remains for the contract to specify clearly whether the power to be paid for is to be measured on the primary or secondary side of the thansformers. If not clearly specified, the power company will certainly measure it on the primary side, and the customer will, therefore, pay for the loss in the transformers. Either way is equally fair, as long as it is understood beforehand. The "all-day" loss in transformers may be from 3 to 15 per cent., depending on the size, and on the proportion of time during which they are fully loaded, working light, or merely wasting magnetizing current in order to keep them alive and ready for service.

The transformer loss is not usually an important matter where they are large and efficient, and where power is taken on the h.p. year basis, but it may be quite appreciable where the transformers are small, the energy paid for by the kw. hour, and the working hours a comparatively small proportion of the total time the transformers are in circuit.

To illustrate this, assume a factory with a total of 25 h.p. of motors installed. Taking 83 per cent. as the average efficiency of the motors, this corresponds to an input of 22.5 kw. Probably two transformers of 20 kw. each would be put in to avoid total stoppage from breakdown of one transformer; then either transformer could take the average load and the two together would handle any possible peak. This would mean a very small average load on the transformers and, therefore, a high percentage loss, so we will assume the more favorable case of one 25 kw. transformer, for the purpose of this example.

The efficiency of the transformer would usually be given by the makers about as follows:—

Full load.	¾ load.	½ load	¼ load.
98%	98%	97.8%	96.7%

so that the percentage loss at first sight appears small, but these figures do not represent the actual total annual cost of the loss in the transformers.

Assume the factory works 9 hours a day, 6 days a week, 300 days a year, then the total working hours per annum would be 2,700.

The **average** load of the factory, in most cases, would not exceed 40 per cent. of the rated h.p. of motors installed, so that in this case it would be 10 h.p. or 7.5 kw., which would be 30 per cent. of full load on the transformer. The transformer would, therefore, be working at an average efficiency of about 97 per cent.

The kw. hours used per annum would be 7.5 kw. × 2,700 hours = 20,250, so that the loss during **working** hours would be 3 per cent. of 20,250, which equals 608 kw. hours.

We have still to ascertain the loss incurred during non-working hours, which would be 8,760 hours per year, less 2,700, which equals 6060 hours. This is the loss due to keeping the transformers magnetized and ready for service, and after a year or two of use would not be likely to be less than 1¼ per cent.; 1¼ per cent. of 25 kw. for 6060 hours is 1894 kw. hours.

The total loss is, therefore, 608 kw. hours during working hours and 1,894 kw. hours during non-working hours, a total of 2,502 kw. hours, or over 12 per cent. of the total kw. hours used. In many cases the loss is undoubtedly greater, so that the question as to whether the power is to be measured on the primary or secondary side of the transformers is worthy of consideration.

It should, of course, in any case, be clearly specified that the power is to be measured after delivery on the customer's premises, unless it is specially desired to do otherwise, as in cases where the customer provides or finances the transmission line.

In some cases where the power company has to build a transmission line especially for one customer it charges interest on the amount so invested, but reserves the right to supply other customers from that line if the opportunity occurs. In this case the customer should be protected by a clause to the effect that if the line is used to supply other customers he shall thereafter only pay a proportionate amount of the interest.

CANADIAN MINERALS.

The annual report of the Mines branch of the Dominion Government shows the total value of mineral production in 1910 to be $105,000,000, an increase of $13,209,517, or over 14 per cent. Copper amounted in value to $7,209,463; gold, $10,224,910; pig iron, $11,245,630; lead, $1,237,032; nickel, $11,181,310; and silver, $17,106,604.

Metallurgical Comment

T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

DESIGN OF OPEN-HEARTH FURNACES.

Prof. M. A. Pawloff, of St. Petersburgh, Russia, gives out the following data relative to open-hearth furnaces. The original paper appeared in the leading German paper, Stahlund Eisen.

1. Ordinary Gas Furnaces.—The dimensions are determined by: (1) the distance between the bulkheads = L, (2) the distance of the long sidewalls = E, and (3) the height of the roof above the bottom = ho. L × E may be called the bath surfaces.

1. Hearth.—Usually based on the weight of the charge T. The ratio of bath surface S to weight of charge T is not constant in the different furnaces, but decreases regularly with increasing capacity of the furnace. This ratio depends upon the depth of the bath (in Europe not over 300 mm., or 11⅜ in., and often less) and the furnace design. Table I. gives some ratios of modern basic open-hearth furnaces:

Table I.

Charge T Tons.	$\frac{S}{T}$ in Square Feet per Ton.	Path surface S, Square Feet.
12.5	12.9	161.5
15.	12.1	181.7
17.5	11.3	191.8
20.	10.76	215.3
25.	10.22	258.3
30.	9.68	290.6
40.	8.87	355.1
50.	8.61	430.4
60.	8.07	484.2

Sometimes we find $\frac{S}{T}$ somewhat greater, but rarely below above values. If the ratio $\frac{S}{T}$ has been well chosen, the most favorable value for T can be found only by practical experience under running conditions.

2. Dimensions of the Furnace.—The dimensions of the furnace are derived from the hearth. The width of the furnace in Europe is not over 11.5 ft., but in America it is as high as 14.8 ft.; the greatest length is 43 ft. The length of the furnace L may be found from the ratio $m = \frac{L}{E}$ after S has been chosen from Table I. In general m is between 2 and 3; in Europe usually 2½ or 2¾. For larger furnaces m = 3 is recommended. Therefore,

$$E = \frac{L}{m} \text{ and } S = L \times E = L \times \frac{L}{m}$$

$$L = \sqrt{S\,m} \text{ and } E = \frac{S}{L}$$

Table II.

Relation Between Capacity, Length and Width of Open-Hearth Furnaces.

T in Tons.	$\frac{L}{E} = m$	L Feet.	E Feet.	S Square Feet.
30.....	2.66	27.9	10.5	290.5
	2.70	28.	10.3	
40.....	2.70	31.	11.5	355.
	2.75	31.3	11.3	
50.....	2.75	34.4	12.5	430.
	2.80	36.1	11.9	
60.....	2.80	36.8	13.1	484
	3.00	38.1	12.7	

3. The slope toward the tapping hole is greatest in the middle of the hearth, being 1/12 to 1/16 of the width, in average 0.07, which corresponds to the tangens of an angle of 4°.

4. Furnace Volume.—The heights ho above the bath for 40-50-ton furnaces should not exceed 83 in. It depends largely upon the gas quality and quantity and the process in use for making steel. Only local conditions and furnace practice will decide this question, but it can be said that oil-fired furnaces require a greater distance than gas-fired furnaces.

5. Bulkheads.—The air inlet area is usually 23.25-38.75 sq. in. per ton of charged material.

The gas inlet area is 1⅓-2½ times smaller than above values.

The furnaces of the same system the area of the gas inlet decreases regularly with increasing furnace capacity.

	10-Tons Square Inch.	20-Tons Square Inch.	30-Tons Square Inch.	45-Tons Square Inch.	150-Tons Mixer Square Inch.
Air inlet	47.4	38.1	30.2	27.9	12.9
Gas inlet	39.1	29.8	23.6	18.6	7.8
Ratio	1.214	1.281	1.283	1.5	1.66

The reason for this is that the drop in gas pressure, caused by friction, is inversely proportional to the ratio of circumference to area.

Since the ratio $\frac{S}{T}$ decreases with increasing capacity, we may also compute the area of inlets from the ratio of this inlet area to bath surface. The author found that this ratio had an almost constant value, being 3.24 sq. in. for air inlet per square foot (or 225 sq. cm. per square meter).

6. Assuming the width of the inlets, the height is found from above data. The dimensions of the gas inlets are derived from those of the air openings. The author suggests that the ratio of the cross-sections of the air inlets and gas inlets should be proportional to the quantities of heat necessary for heating air and gas or to the quantities of the respective checkers.

7. Gas and Air Flues.—The slope of the gas flues (inlets) varies between 12° and 18°, and that of the air flues between 30° and 40°, and depends largely upon the size of the furnace. In American furnaces the gas burns almost completely, although only a single broa opening forms the gas inlet.

8. Vertical Flues.—Vertical flues have 25 per cent. greater area than their respective inlets for the larger furnaces, and 50 per cent. greater for the smaller (20-25-ton) furnaces.

9. Length of Bulkheads.—The length of bulkheads depends upon the type of the different furnaces. The distance between vertical gas flues and gas inlets is between 9.8 ft. and 13.1 ft.; for air flues the distance is between 4.9 ft. and 8.2 ft.

Regenerators.

10. Volume.—Modern practice per ton charge is 176.6 cu. ft. checkers for small European furnaces and 123.6 cu. ft. for the largest American furnaces. In economically working furnaces, which have a low temperature drop (about 120° C. or 216° Fahr. per hour) between two reversals, the author finds that there are 90 to 110 lb. checkers per pound of coal consumed per hour.

The author recommends to base the design of the checkers on the bath surface. By using the above values of the ratio S ÷ T, the checker volume per unit of hearth surface is almost constant = 4.5 cu. m. per square meter = 14.76 cu. ft. per square foot.

11. Dimensions of Regenerators.—The checkers in large furnaces are 80 per cent.; in smaller furnaces, 70 per cent. of the entire chamber volume. The depth of the checkers should not be less than 13 ft., and if possible 16 ft. The ratio between air and gas chambers varies between 2 and 1 For cool producer gas it is 1.5 and for hot gas 2; 1¾ being a fair average ratio.

Chimney Flues and Reversal Apparatus.—These dimensions are often too small, because in the case of rebuilding a furnace these parts are usually left unchanged.

12. In satisfactorily working furnaces the smallest area of air flue per 100 sq. ft. bath surface is 2 to 3 sq. ft.; the area in the reversal valves should be at least 3 sq. ft. per 100 sq. ft. hearth surface.

13. Instead of giving air and gas valve the same dimensions it is better to make the ratio of their cross-sections equal to the ratio of the cross-sections of their flues or to the ratio of their respective checker volumes.

14. Flues Between Valves and Chambers.—Flues between valves and chambers are made with twice the cross-section of the valve flue cross-section. Thus, for the air flue a cross-section of about 6 sq. ft. is chosen per 100 sq. ft. hearth surface.

15. Flues Between Valves and Stack.—The cross-sections of the flues between valves and stack should equal the sum of the cross-sections of the two flues which run to the valves of one side.

16. The same area has to be given to the stack at its base. The opening at the top of the stack is 1/20 S where S is the bath surface, making the diameter $d = \frac{\sqrt{S}}{4}$

The height of stacks should be 131 to 148 ft. for larger open-hearth furnaces.

II.—Oil-Fired Furnaces.—The ratio $\frac{T}{S}$ remains the same. The distance between roof and bath has to be greater to give the oil time for complete combustion; for 20-25-ton furnaces this height should be 71-79 in. The air inlet should be 4 sq. ft. per 100 sq. ft. hearth surface.

The volume of the air checkers should be 11.5 cu. ft. per square foot hearth surface, and on account of the high heat value about 140 to 160 lb. of checker should be used per pound of coal gasified per hour.

The cross-section of the flue to stack should be about 8.5 sq. ft. per 100 sq. ft. hearth furnace. The valve area and the opening of the stack at the top should be 4.25 sq. ft. per 100 sq. ft. surface.

THE ENDURANCE OF METALS.*

Experiments on Rotating Beams at University College, London.

By E. M. Eden (Armstrong College, Newcastle-on-Tyne), W. N. Rose and F. L. Cunningham.

When a piece of metal is subjected to alternating or intermittent stress the metal may fracture after a large number of alternations or repetitions of stress, although the maximum stress applied is considerably less than would be required to fracture the material with a single application. As in the large majority of cases metals used by engineers are subjected to varying stresses, and as failure when it does occur usually happens after a large number of repetitions of stress, the importance of tests on alternating stresses is very great. It is doubtful if a direct tensile test of a piece of steel gives any very definite information of its capacity to resist alternating stresses. The hard brittle-looking fracture of steel broken under repeated repetitions of stress is entirely different from the fracture caused by the single application of a larger stress in a testing-machine, and the hard-looking fracture of a broken piston-rod or crank-shaft is often taken as a proof that the material is or has grown too brittle for such service. The appearance of the fracture in such cases is probably responsible for the common idea that a soft ductile material is most suitable for withstanding alternating stresses.

The classical researches of Wöhler included experiments on repeated tensions varying from o to a maximum, repeated torsion, and on revolving bars subjected to a bending-moment while revolving; in this last case the stress in the outside fibres varies from a maximum tension to a maximum compression, and the range of stress is twice the maximum imposed stress. In every case the number of repetitions to cause fracture increases as the stress diminishes.

If a number of experiments with different maximum stresses applied are considered, and the applied stress is plotted against the number of repetitions to cause fracture, the points are found to lie more or less on a curve which appears to become nearly horizontal afer a few million repetitions. The stress where the curve is horizontal is the limiting stress which can cause fracture after an indefinite number of repetitions.

Culture, friendship and inspiration, these three, and the greatest of these is inspiration. This is the one thing which all the others lead to, for this is the true vision.

Tests were undertaken with a view to finding, if possible, the form of the stress-repetitions curve for any one material and to determine the effect of speed, or rate of alternation of stress on the stress-repetitions curve and on the limiting resistance for an indefinite number of repetitions. The testing-machine was specially designed and built with these objects in view, but the tests deal also with the comparative endurance of various materials and with the effect of rests, vibration, surface and form of test-piece, and annealing on endurance.

The testing-machine was of the revolving-beam type, in which the test specimens are subjected to a uniform bending-moment while revolving on their own axes. With truly turned test-pieces and holders the machine runs quietly.

The results of tensile tests of test-pieces cut from some of the bars of metal used for the endurance tests are shown in Table I. All the tensile tests were made on the full-size bar, and extensometer readings were taken on a 10-in. length.

*Abstract of paper read, October 20, before the Institution of Mechanical Engineers.

It is generally assumed that the stress-revolutions curve becomes horizontal after a sufficiently large number of repetitions of stress, and the ordinate of the curve where it is horizontal is the limiting stress causing fracture after an indefinite number of alternations or repetitions of stress. An examination of the curves which the authors give shows that this limiting stress is not reached with one million revolutions; this is seen more clearly in the logarithmic curves, which are also plotted, where, as in the case of the other curves, the limiting stress is the ordinate of the curve when it becomes horizontal. In spite of the irregularities in the position of the points, it seems to be certain that the curves have not become horizontal after one million revolutions.

Table I.

Bar No.	Material.	Limit of elasticity. Tons per sq. inch.	Tenacity. Tons per sq. inch.
5	½-inch bright drawn mild steel rod, Quality B	28.8	40.0
8	½-inch bright drawn mild steel rod, Quality A'	25.0	35.7
9	Vanadium steel Type A, oil-tempered	46.5	57.2
10	Vanadium steel Type A, annealed	26.8	38.4
23	½-inch blued rolled Bessemer steel, Quality D	35.7	49.3
25	3 per cent. nickel steel	44.6	57.0
26	25 per cent. special nickel steel	24.1	48.8
27	½-inch bright drawn wrought-iron rod	25.9	33.3
28	½-inch bright drawn wrought-iron rod	26.8	34.0
29	½-inch bright drawn wrought-iron rod	26.8	34.1

The limit of elasticity was obtained from extensometer readings, and is the limit of the straight portion of the stress-strain curve. Both the limit and tenacity are expressed in tons per square inch of original area.

TITANIUM IN RAILS.

A set of sections illustrating the wear of rails laid down on the Kessler's Curve in West Virginia, on the Baltimore and Ohio Railroad, have been issued by Messrs. T. Rowlands and Co., Stirling-chambers, Sheffield. The diagrams have been drawn out by Messrs. Robert W. Hunt and Co., New York, for the Titanium Alloy Manufacturing Company, Pittsburg, and deal with open-hearth and titanium-treated Bessemer rails. The curve on which these tests were made is one of 9 degrees, the superelevation of the outer rail being 6 in. 90-lb. rails were used. A previous test of ordinary Bessemer and titanium-Bessemer rails on this curve showed an improvement in favor of the latter of 294 per cent. In the present test, the difference in favor of the titanium rails is not so great. The test extended for 338 days, the loss being measured in square inches of sectional area. Of the rails on the inside of the track, the open-hearth rails averaged a loss of 0.250 sq. in., and the titanium rails as follows:—0.03 per cent. titanium, 0.273 sq. in.; 0.05 per cent. titanium, 0.169 sq. in.; 0.1 per cent. titanium, 0.155 sq. in.; 0.15 per cent. titanium, 0.147 sq. in. The wear was even all across the head, and the open-hearth rails thus showed 1.70 times the amount of loss of the 0.15 per cent. titanium rails. On the outer rails the wear was principally, of course, on the inside of the head, the wear being as follows:—Open-hearth, 0.36 sq. in.; 0.03 per cent. titanium, 0.428 sq. in.; 0.05 per cent. titanium, 0.39 sq. in.; 0.1 per cent. titanium, 0.389 sq. in.; 0.15 per cent. titanium, 0.273 sq. in. The ratio of wear of the open hearth to that of the 0.15 per cent. titanium rails is thus 1.32:1. The average ratio for the loss of all open-hearth rails to the 0.15 per cent. titanium rails, on both sides of the track, is 1.45:1. It may be added that the open-hearth rails were of 0.64 carbon steel, while the titanium Bessemer rails averaged 0.47 carbon. A test carried out some time ago on the Chicago, Burlington, and Quincy Railway, lasting for nine months and including nickel, maganese, plain open hearth, Bessemer, and two makes of titanium rails, showed that the titanium rails, of which the extra cost per ton is only about 2 dols., were equal to the nickel-steel rails, the extra cost of which per ton was no less than 40 dols., being, moreover, superior to the other makes covered by the test.

POWER REQUIRED FOR ROLLING MILLS.

Prof. M. Hermann (Stahl und Eisen) derives the following simple formulas from theoretical considerations and from a study of the recent investigations of Puppe. These formulas apply to the rolling of rectangular sections:

Let A = Reduction of sectional areas per pass, in sq. in.;
k = Limiting stress of lateral extension of metal, lb. per sq. in.;
t = Reduction of thickness of billet per pass, in inches.
D = Roll diameter, in inches;
v = Velocity of bar leaving rolls, ft. per sec.
a = Arc of contact of billet with the roll, in degrees.

Then,

$\cos a = 1-(t/D)$, from which sin a may be found from tables.

Force required to draw billet through the rolls: $F = 2k A$.

Roll pressure, in lb. $= P = k A [1+(1-\cos a)/2]/\sin a$.

H.P. (exclusive of power required to run rolls empty) $= F v [1.1+0.12 (P/F)]/550$.

The value of k is difficult to assign; it increases with the number of passes and decreases with increasing temperatures. Herr Hermann gives a table taken from Puppe's experiments in which k (average) for the 5th to 8th passes ranges from 6,940 lb. per sq. in at 2,237 deg. F. to 10,042 lb. per sq. in. at 2,091 deg. F.; and for the 9th to 17th passes from 7,965 lb. at 2,237 deg. F. to 11,547 lb. at 2,091 deg. F.; or mean values of k for the 12 passes ranging from 7,609 lb. at 2,237 deg. to 11,265 lb. at 2,091 deg.

Example.—Let A = 4 sq. in.; k = 8,000 lb. per sq. in.; t = 0.75 in.; D = 20 in.; v = 6 ft. per sec.

Then,

$\cos a = 1-(0.75/20) = 0.9625$. whence $\sin a = 0.2712$.

$F = 2 \times 8000 \times 4 = 64{,}000$ lb.

$P = 4 \times 8000 [1+(1-0.9625)/2] \div 0.2712 = 120{,}206$ lb.;

$P/F = 1.8782$.

H.P. $64000 \times [11.6+(0.12 \times 1.8728)] \div 550 = 925$.

HYDRO-ELECTRIC POWER IN CHILE.

It is proposed, in a report submitted to the Chilean Ministry of Industry and Public Works, to divide the hydraulic works department into sections—(1) hydraulic surveys (2) power stations (3) transmission of electric energy; to expropriate as soon as possible all the hydraulic undertakings which it may be thought desirable to be worked by the State; and to encourage the development of other hydraulic projects by private enterprise in the most efficient manner. It is also proposed to investigate the requirements of the State railways, and the possibility of employing hydro-electric power for military and naval arsenals. The first part of the programme will comprise inquiries to be made during a period of five years in connection with the rivers Aconcagua, Maipo, Cochapoal and Bio-Bio.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS.

The Theory and Practice of Technical Writing. By Samuel Chandler Earle, Professor of English in the Engineering School, Tufts College. The Macmillan Company, New York and Toronto, Canada. Cloth; 5x7½ ins.; pp. 301; many text illustrations. $1.25 net.

The present tendency in the engineering schools is to devote more time to the study of English. It is only recently, however, that such instruction has been given. This instruction has varied in different schools, and falls into two general classes. The first class is that in which English is taught as a purely cultural part of the curriculum. This teaching is often given with the other students taking a general arts course. Many of the schools in the United States, however, have given separate instruction to the engineering students, and as a result there has developed a course of lectures specially adapted to their needs. This has naturally led to a specialization of the teaching of English, which may be called technical English, and this is the second class. The command of good technical English is as essential to the engineer as the other elements of knowledge which go to make up the well balanced man. This is coming to be appreciated more and more. Few of the engineering schools do not now give instruction along these lines.. Therefore any book dealing with the subject of technical writing is of interest from this point of view.

However, this book by Professor Earle is of interest to more than the engineering student or the teacher. Professor Earle draws attention to the fact that the engineer makes use of a form of expression no less special than that of the lawyer, the novelist, or the poet; and the engineer no less than the members of the other professions, needs special training in writing, over and above all that he may get in general composition. In this volume a study of some of the fundamental problems of technical writing is given in an accurately, orderly and logical sequence.

The book will be of service to the student as an introduction to technical writing, and to the engineer of some years' standing, as a concise presentation of what he perhaps already appreciates in a general way.

Theory and Practice in Designing. By Henry Adams. Published by Constable & Company, London. Cloth; 5¾ x 8¾ in.; 240 pp., including index; 371 illustrations. Price $2 net.

The author has written many books on designing, but this one is quite distinct from the others. In this treatise the theory of structures is dealt with, from the most elementary examples of simple beams and columns, to the more involved cases of trusses, continuous girders, arches and suspension types. Elementary mathematics are used throughout, and graphic status are used wherever possible.

The subject matter taken up includes safe loads, stresses in different structures, bending moments, moments of inertia, foundations, riveting, designing of girders, trusses, roof trusses, columns, cantilevers, suspension bridges, arches and retaining walls. In fact, the subjects covered are too numerous to allow of very extensive treatment in the book; for this reason formulae are given without their theoretic analysis and basis. There are many valuable details given throughout the volume which will appeal to the young designer. The different elements of design are illustrated by examples which are worked out arithmetically.

The book appeals more to the draughtsman and designer who has not had the advantage of a course in a technical college, and who is without a knowledge of higher mathematics. To such a man the book will be valuable. It should also be useful to the architect and structural engineer. It, however, would have been better to have omitted on the other hand the inclusion of such matter as the elementary principles of trigonometry, and at the extreme, the treatment of arches and suspension bridges. This constitutes the objection to the book in that the attempt is made for too broad a treatment of the subject of design of structures.

Aside from the above mentioned objection, the book will be found to be a useful one.

Structural Engineering. By Joseph Husband and William Harby. Publishers: Longmans, Green & Co., London. Cloth; 6x9 in.; 396 pp.; 32 tables; 337 cuts. Price $2.50.

Books on structural engineering fall usually into two classes: those which treat the subject from a purely theoretical standpoint and those which deal mainly with regard to the practical arrangement of structural details. Between the theoretical analysis of stresses and loads and their application to a practical design there exists a gap which, in the literature existing at the present time on the subject, is not very well bridged. In this volume the endeavor is made to combine these two divisions, treating the theoretical side of the design first and leading up to the practical application to the actual incorporation in the structure of the different elements composing the finished work. The mistake so often made in volumes treating technical subjects, of endeavoring to cover too wide a field, has been avoided, by confining the consideration to simple structures and details of everyday occurrences. This principle could have been carried to advantage even further by omitting a chapter on the materials of construction. The book is well arranged, leading logically from loads and stresses, bending moments and sheering forces to the elements making up the structure, such as beams, columns and struts, plate girders and lattice girders; then follow chapters on deflections, roofs, miscellaneous applications and tall buildings and masonry and masonry structures.

The chapter on columns and struts is very good, covering the different formulae in use, noting their applications and restrictions, and giving many numerical examples when applied to actual design.

The book is a decide d addition to the literature of the subject and should prove of general utility to the student and draughtsman having occasion to make use of it.

Home Waterworks. By Carleton J. Lynde. Published by Sturgis & Walton Company, 31 East 27th Street, New York. Size, 5x7. Pages, 280; illustrated. Price 75c. net.

The obtaining and introduction of water into houses and outbuildings, and the domestic utilization of water-power are

the subjects treated in this volume. This thoroughly practical book meets a widely recognized need for information, and is written by a specialist.

Thousands of men living in rural parts of Canada, out of reach of a public water system, have equipped their homes with water supply conveniences equal to any found in the cities. Thousands more who could well afford to do so and who could do so advantageously, have not done so for various reasons—because the idea has not occurred to them, or because they did not know how to go about it, or because they mistakenly thought the expense too great. To all such this book should prove of the greatest practical help.

The author of the book is Professor C. J. Lynde, of Macdonald College, Quebec, and the book contains chapters on the value of water indoors; first steps in kitchen equipment; sources of water supply—underground water; sources of water supply—wells and their requirements; sources of water supply—springs, rivers, lakes, and cisterns; properties of air supplied in pumps; pumps and their action; standard types of pumps; running water—the pneumatic tank; the siphon—the hydrostatic paradox—the kinetic theory; methods of pumping—hand power, horse-power and windmills; methods of pumping—the hydraulic ram; methods of pumping—the hot-air engine; method of pumping—the gasoline engine and steam engine; method of pumping—the electric motor; water power; plumbing and sewage disposal; acknowledgment; firms dealing in water supply and plumbing materials.

In addition to a table of contents there is an index well arranged and complete.

The book is interestingly written, and is correct as to statements, and is not so technical that it confuses. Being a manual of water supply in country homes, it is written more for the general reader than the engineer, yet the engineer will find much of interest.

The Canadian Almanac. Published by Copp-Clark Company, Toronto. Paper; 6 × 8¾ in.; pp. 504. Price, 60c. net.

This volume is now in its sixty-fifth year of publication. Every editor has seen additions and improvements rendering it more convenient and complete and ready of reference. The result of this continuous attention is exhibited in the numerous lists and pages of information not found elsewhere and presented in a way that saves much expenditure of time and pains. The publishers justly claim that in no other volume can so much information about Canada be found in so small a space. Among the principal subjects covered are the astronomical and tide tables; the complete customs tariff; weights and measures and foreign exchange. The banks, branches and names of managers are given; patents in Canada receive attention, and a full Canadian militia list is included. Complete post and postal information and newspaper statistics; particulars regarding the Dominion and Provincial Governments, the clergy of all denominations, the legal profession, educational institutions, life assurance companies and other societies are all to be found within its boards. This edition also includes maps of Manitoba, Alberta and Saskatchewan, showing railways and principal towns. The volume is clearly printed and is in every way a credit to its publishers.

Mechanics of Materials. By Professor Louis A. Martin. Published by Wiley & Sons, New York. Renouf Company, Montreal, Canadian agents. No. of pages 210; size 7½ × 5½. Price, $1.50.

Professor John Perry, speaking of the use of the mathematics by students, somewhere asserts that although they may be able to pass difficult examinations in the calculus, and to differentiate any function of x and to integrate many, their mathematical knowledge seems to be of no use to them in practical engineering problems. Professor Martin, in his academic work has evidently realized the same difficulty, for in "Mechanics of Materials" his method of treatment has been manifestly designed to encourage the student to apply his mathematical tools.

The little volume bearing the above name is the third of a series in uniform size, type and binding, issued by Professor Louis Martin, of Stevens Institute. Like its predecessors, it claims to be a text-book rather than a treatise and in this instance covers the work usually taught in schools of engineering as an introduction to structural and mechanical design. The work presupposes a knowledge of the conics and of the infinitesimal calculus as a preparation on the part of the student, and as stated above, the use of the latter in the derivation of formulae and the solution of problems is frequently made.

The volume devotes a chapter to stress and strain, and Hooke's law and proceeds at once to the theory of the beam. Of its two hundred pages over eighty are devoted to this element, and in consequence the treatment is quite as full as one would expect in a volume of its scope. The author in this connection develops in conjunction with, and by the aid of, graphics, the principle that the Moment, Shear and Load diagrams are derivative curves; that is, that the shear is the first derivative of moment, and method of loading the second, with respect to axial distance. This view will be instructive to students who have been previously trained to regard, for example, velocity and acceleration as the first and second derivatives of space with respect to time, and the one will undoubtedly elucidate the other.

Subsequent chapters are devoted to columns and struts, torsion in shafts, thin and thick cylinders under internal pressure, an introduction to the mathematical theory of elasticity and what in the texts is commonly known as compound stress. The writer is not quite clear why no reference is made to riveted joints.

The volume has much to commend it. The graphics are good, as is also the selection of problems, 276 in all, illustrating applications of the theories discussed. For these, the answers are appended, providing a source of much satisfaction to the conscientious students. A perusal of them shows, also, that the author is not merely an academician. The book will be read with profit by both teachers and students of the subject.—P. G.

Analytical Mechanics. By Professor Edwin Barton, University College, Nottingham. Published by Longmans, Green & Company; 525 pp.; 6 × 8¾. Price, $3.

This book differs from many recent texts for the use of students of mechanics in the extent of the field it covers. The tendency toward extreme differentiation in the teaching of science and the compilation of texts is evidently not regarded sympathetically by Professor Barton, for the excellently thorough work at hand discusses in turn Kinematics, Dynamics, Statics, Hydromechanics and Elasticity—subjects to each of which the modern tendency is to denote an entire volume. To read it intelligently, the student should possess a working knowledge of the differential and integral calculus and of differential equations, so that the text can scarcely be described as elementary. In fact the volume is manifestly intended more for the student of Pure than of Applied Mechanics, in that the exemplification of principles is rather more academic than practical, yet, notwithstanding this, it will be generally conceded that a knowledge of its contents would be of inestimable value to the student contemplating the study of engineering science. Occasional reference, his-

torical and otherwise, is made to the classics of Galileo, Newton, Thomson and Tait, Gauss, Lodge and others, but as to the controversial questions concerning the philosophical basis of the science, the author displays a commendable toleration. The large collection of selected problems is an excellent feature of the book, whose usefulness would undoubtedly have been somewhat increased had the answe s to these been appended. In contrast with some of the texts that have appeared during recent years, especially from the American press, this volume displays discrimination in the compilation of matter, system in its arrangement, and care in its editiing, and on the part of the author, capacity and thoroughness. The book will constitute a real addition to the literature of this subject.—P. G.

Practical Cement Work. By W. B. Henry. Published by The Concrete Age Publishing Company, Atlanta, Ga. Size, 4 x 6½ in.; pp. 110. Price, 50c.

A practical little book on cement construction, which will be of interest to any one identified with the cement or building industry. The book contains short chapters on the materials of concrete and its use in construction.

Modern American Telephony. By Arthur Beasey Smith. Published by Frederick J. Drake & Company, Chicago, Ill. Size, 4½ x 7; leather bound; 790 pages, including index; 470 illustrations. Price $2.

This book is a treatise on Telephony in all its branches, compiled and edited by Mr. Smith. It includes descriptions of the installation, operation and maintenance of telephones, with a description of the different systems, chapters on power plants, different types of switchboards, protective devices, measuring instruments, line construction, etc. This is a book for the telephone engineer and the workers on telephone switchboards.

Ship Wiring and Fitting. By T. M. Johnston. Published by Constable & Co., Ltd., London. Cloth; size, 4¼ x 6½; 77 pages; illustrated. Price, 50c.

This book is intended to treat in a simple manner the systems of wiring most commonly used in the fitting of electrical apparatus on vessels of the mercantile class. The different adverse conditions which have to be contended with in installing electrical apparatus and the precautions necessary for safeguarding the efficiency of the work are discussed. The book is a concise treatise on the subject, and forms one of the electrical installation manuals issued by the publishers.

The Waterpowers of Canada. Issued by the Commission of Conservation, Canada, James White, Secretary. Authors, Leo. G. Denis and Arthur V. White. Cloth, 7 x 10 in., 397 pp.; well illustrated.

The first inventory ever taken of the water-powers of Canada has been completed by the Commission of Conservation and the results embodied in a large and profusely illustrated report just issued. The investigation made by the Commission, which has extended over a period of two years shows that there are 1,016,521 horse-power developed from water-power in Canada. Every phase of the subject from the laws governing the disposition of water-powers in the various provinces, to the actual physical data regarding each individual water-power concerning which information was obtainable, is treated in the report. In addition, there is a very full bibliography of 30 pages, and the appendices giving, among other things, the text of the laws concerning the export of power and also of the treaty recently concluded with the United States regarding the establishment of an International Joint Commission.

The volume opens with two chapters of an introductory nature that are concerned mainly with the general economic bearing of water-powers on national development. The relation of water to agriculture, mining, navigation, domestic supply and so forth, is dealt with, and the principles to be used in the interpretation of water-powers data are stated and discussed critically. The broad and optimistic statements very often made on the platform and in the press regarding our vast water-power resources are deprecated. To quote from the Report, "General statements implying that the aggregate amount of water-power must be great because the total water area, or watershed area is so great, or because there are so many lakes and rivers, are generalities to be considered of very little definite value . . . One of the chief dangers of such generalities is to create in the popular mind a feeling of unwarranted assurance that, even though desirable water-rights are being granted by a government, yet there is so much left that no apprehension may be entertained regarding the amount of power rights being parted with."

A chapter is devoted to the water-powers of each province in which the general features of the province as regards water-power development are discussed and an outline given of the law whereby powers are granted or leased to private individuals or corporations. The larger developments are also described. The statistical data given in tabular form includes the height of the fall, the horse-power that may be developed, the present development and the main uses to which the power is applied such as lighting, pulp and paper making, etc. Reference is also made to the possibility of increasing the amount of power developed by storage reservoirs and dams where such are feasible.

The power situation in Ontario is treated very fully, special attention being given to the power possibilities at Niagara and the conditions affecting development there. Each of the power companies operating there, whether on the Canadian or American side, is described in detail. A significant reference is made to the granting of franchises to develop power at Niagara Falls. The report states that the low-water flow of the Niagara river would yield at the Falls, about 2,250,000 H.P., of which Canada's share (one-half), would be 1,125,000 H.P. "Franchises have already been granted," it goes on to say, "and plants partially completed, for the development on the Canadian side of the river, of about 450,000 H.P. In other words, instead of 'millions' of horse-power being available, as has been sometimes stated, it appears that about half, and by all odds the better half, of Canada's usable share of Niagara Falls power has already been placed under private control."

The volume embodies all the useful information regarding the water-powers of Canada that has heretofore been collected and this has been supplemented and, in many cases, verified, by field surveys, conducted by the engineers of the Commission. In fact, all the information regarding the Maritime Provinces powers was obtained in this way last year by the experts of the Commission. The data regarding the Western Provinces was found to be so incomplete that it was decided to make special investigations of the powers in those Provinces, the results of which will be published next year in the form of a report on the "Water-Powers of Western Canada." The engineers of the Commission are now engaged upon this work.

PUBLICATIONS RECEIVED.

Publications of the Canada Department of Mines, Mines Branch. The production of cement, lime, clay products, stone and other structural materials in Canada during the calendar year 1910.

The Production of Coal and Coke in Canada during the year 1910.

The Production of Iron and Steel in Canada in the year 1910.

A general summary of the mineral production of Canada during the year 1910.

The above four pamphlets are edited by John McLeish, chief of the division of mineral resources and statistics.

Geological Surveys Branch. The Bighorn Coal Basin, Alberta. Memoir No. 9E; by G. S. Malloch.

The Clay and Shale Deposits of Nova Scotia and portions of New Brunswick. Memoir, No. 16E; by Heinrich Ries, assisted by Joseph Keele.

Report of the Department of Naval Service for the year ending March 31st, 1911. Price 10c.

Forty-fourth annual report of the Department of Marine and Fisheries, 1910 and 1911. Price 30c.

Bulletin No. 229. Olive Oil, issued by the Laboratory of the Inland Revenue Department, Ottawa, Canada.

Bulletin No. 227. Fertilizers; Laboratory of the Inland Revenue Department, Ottawa, Canada.

Avalanches and Forest Cover in the Northern Cascades; by Thornton T. Munger. Circular No. 173, Forest Service, United States Department of Agriculture, Washington, D.C.

The Year Book of British Columbia, 1911. Issued by the Government of British Columbia; bound in red cloth and containing a manual of provincial information. Copies of the Year-Book may be obtained at $1.15 per copy by applying to the King's Printers, Victoria, B.C.

Report of Proceedings of American Mining Congress. Fourteenth annual session held in Chicago, Ill., October 24th to 28th, 1911. Published by the American Mining Congress at the office of the Secretary, Denver, Col.

The Concrete Institute. Transactions and Notes. Vol. III. Published November, 1911, at the offices of the Concrete Institute, Denison House, 296 Vauxhall Bridge Road, Westminster, England.

Factories and Warehouses of Concrete. Published by the Association of American Portland Cement Manufacturers, Philadelphia, Pa. Price 50c. Part of this volume was published in a recent issue of The Canadian Engineer. The Canada Cement Company, of Montreal, have ordered a number of these books and will send them out free to architects, engineers and manufacturers, except for the cost of mailing, which will amount to 12 cents. Copies may be secured from L. S. Brunner, manager of publicity, Canada Cement Company, National Bank Building, Montreal.

Saxon Portland Cement Company Diary. A diary for 1912 issued by the Saxon-Portland Cement Company, of Cambridge. Bound in a very artistic manner with padded blue cover. Copies may be had from the Saxon Portland Cement Company, Cambridge.

CATALOGUES RECEIVED.

Scraper Bucket Excavators. Pamphlet No. 427; issued by the H. Channon Company, Chicago, Ill., illustrating different types of their scraper bucket excavators. A very handsome catalogue.

Automatic Sprinkler Bulletin. Issued by the General Fire Extinguisher Company, New York, January, 1912.

Continuous Feed Bronzing Machine. Pamphlet illustrating the Kolboch Flat Continuous Feed Bronzing Machine. United States representatives, C. B. Henschel Manufacturing Company, Milwaukee, Wis.

Carbonizing Coating. Pamphlet issued by the Goheen Manufacturing Company; illustrating different works on which their carbonizing coating for the preservation of steel has been used.

Compressors. Bulletins 34A, C. E. and H, issued by the Chicago Pneumatic Tool Company, illustrating different types of their steam-driven and gasoline-driven compressors, with instructions for installing and operating. Offices, Fischer Building, Chicago; 50 Church Street, New York.

Air Compressor. Folder issued by Canadian Rand Company, Commercial Union Building, Montreal, illustrating the Rand Class "C2" compound straight line, steam-driven air compressors.

"SKF Radial Bearings" is the title of a bulletin just issued by the S.K.F. Ball Bearing Company., 50 Church St., New York. This bulletin explains the construction peculiarities, particularly the provision of self-alignment, of SKF Radial Bearings, and gives dimensions, speeds and capacities of the principal types and sizes.

Boiler Tools. An illustrated folder showing the Faessler octagonal sectional expanders, roller expanders, and flue cutting machine. Return post card attached. J. Faessler Manufacturing Company, Moberly, Mo.

Sewage Lifting Apparatus. "The Priestman Ejector System" and "Progress in Sewage Treatment No. 7" have just been issued by Merritt & Company, Camden, N.J., and deal mainly with the Priestman Ejector System and the subject of Sewage Pumping. "The Priestman Ejector System" is in the form of a proposition containing 14 pages, size 8½ × 11, and takes up first the various applications of the Priestman hydro-pneumatic ejector, as for instance, in parts of a sewer system at sewage purification works, or for the basement of deep buildings. These applications are discussed at further length after a page devoted to a concise description of how a Priestman Ejector operates without any moving parts in contact with the sewage and how the compressed air is made to work expansively for discharging sewage. In subsequent pages the various advantages of this type of sewage pumping apparatus are given, and also details regarding its construction. A table of standard types covering capacities from 5-2000 G.P.M. and tables giving the dimensions of standard ejectors of both the vertical type and hemispherical type are then given. Standard dimensions of the horizontal type are not included since, as it is stated, the design and installation of horizontal ejectors depends upon local conditions. Ejectors of this type are used where the amount of head room available is very limited. The last two pages comprise data sheets which outline the figures which are necessary for proper recommendation of the ejector systems in basements of deep buildings or for city pumping stations.

The second publication "Progress in Sewage Treatment No. 7" is a technical paper, size 6 × 9, 24 pages, 18 of which are devoted to articles, 3 to editorial matter and 3 to advertisements. The leading article is from a report by Mr. Geo. T. Hammond, M. Am. Soc. C.E., and is entitled "Automatic Sewage Lifting Station Equipment." It analyzes the various advantages of the centrifugal pump and the compressed air ejector, pointing out among other facts that "the pneumatic ejector is an especially satisfactory means of lifting sewage wherever a reliable apparatus is desired for handling a small quantity of flow, or a considerable quantity coming to the plant in a variable amount. The centrifugal pump works best where the flow is quite constant and of considerable quantity."

Several valuable tables are given, as for instance the average efficiency of centrifugal pumps and of compressed air in pneumatic ejectors. Following Mr. Hammond's article, some six pages are devoted to an article on pneumatic ejectors abstracted from the Surveyor, London, and another describing the sewage ejectors at the Pennsylvania Station,

N.Y. The eighteen Priestman Ejectors in use at this plant handle a flow of sewage equivalent to that which would be contributed by a city of 40,000 inhabitants.

In the editorial section a page is devoted to the Water Waste at Memphis, by flush tanks, and another to the subject of Mr. Hammond's paper. Particular reference is made to the table of efficiency of compressed air in ejectors, and a note is given covering the equations for adiabatic air compression.

Both of these publications, i.e., "Progress in Sewage Treatment No. 7," as well as "The Priestman Ejector System" are for general distribution, and will be sent upon application to the Hydraulics Department, Merritt & Company, Camden, N.J.

TESTS OF PULLEYS.

An extended series of tests was recently made with different kinds of pulleys transmitting power by means of leather belts, on a belt-testing machine in the laboratory of Sibley College, Cornell University. The tests were all made with single-ply oak-tanned leather belts 5 in. wide, 0.224 in. thick and 33 ft. long. The pulleys were all nominally 24 in. diam. with 8-in. faces. A constant belt speed of 2,200 ft. per min., or 348 r.p.m. of the driving pulley, was maintained throughout. Cast-iron, wood, and paper pulleys were used, including some with cork projections. The exhaustive character of the tests is shown by the fact that for cast-iron pulley tests alone nearly 9,000 observations of the slip of the pulleys were taken.

The results of these tests were given, in a paper by Prof. W. M. Sawdon, before the National Association of Cotton Manufacturers.

The tests showed that for slips of 1 to 2 per cent., as commonly used in practice, the plain cast-iron pulley had the lowest values of coefficient of friction and the plain paper pulley had the highest. The values of the plain wood pulley lay between these limits. Wood pulleys up to ½ per cent. slip followed very closely the performance of the paper pulleys, after which the slip increased rapidly, and at 1 per cent. the coefficient of friction was only approximately a mean between those of the cast-iron and the paper pulleys. Beyond 3 per cent. slip the coefficient of friction was less than that for cast iron. This condition explained in part a commonly accepted understanding that the wood pulley had a small capacity for carrying an overload. To take care of overload capacities as much as 50 per cent. of the normal load, the wood pulleys must be designed larger in diameter or for use with a wider belt than the normal load would demand.

Pulleys with cork inserts 1¼ in. diameter, set in 1 1/16 in. diameter sockets and spaced 2¼ in. between centres, and of composite construction, were tested. This gave a cork area of from 37 to 39 per cent. of the total pulley face. The usual practice was to make the cork area from 25 to 33⅓ per cent. of the total area. Two separate and complete tests were made on the cork inset pulleys, one for a projection of the corks of approximately 1/32 in. beyond the pulley face and the other for a projecion of approximately 1/64 in. In the case of the cast-iron pulleys, each of the cork-insert curves showed a material increase in the values of the coefficient of friction at lower slips and running up to 3 per cent. For the longer corks the values of the coefficient of friction between 1 and 6 per cent. slip were close to those of the plain wood pulleys. Below 1 per cent. slip the wood pulleys had the higher values. With the shorter corks, considerable advantage was shown over plain cast-iron pulleys as well as plain wood pulleys up to about 4 per cent. slip, after which the coefficients were but little higher than for the plain cast iron. Either of the cork insert cast-iron pulleys, however, showed a large overload capacity at high slips. In the wood pulleys the cork inserts slightly increased the transmitting capacity for very low slips and up to about ⅛ of 1 per cent. Between ½ and 1¾ per cent. slip the plain wood pulleys had the higher values, while beyond 2½ per cent. the cork inserts again showed an advantage. This was particularly interesting in that, though capable ultimately of carrying much greater loads, through the allowable ranges of slip, the cork inserts actually proved detrimental. The tests on the paper pulleys with cork inserts were also interesting in that in each case the use of cork inserts had proven detrimental to the transmitting capacity of the pulleys for practically the entire range of slip. For the longer cork projection this was more marked than for the shorter. Unfortunately, in the paper and in the cork pulley tests, the capacity of the machine did not permit of higher loads being carried to determine the maximum values of the coefficient of friction and corresponding slips.

A NEW BRIDGE IN EGYPT.

In connection with the opening up for navigation purposes of that branch of the River Nile at Cairo, known as the Bahr-el-Aama, and the proposed realignment of the navigable channel of the river, tenders for the construction of an entirely new bridge to replace the existing Pont des Anglais were invited by the Egyptian Public Works Department from all the leading bridge engineering firms of Great Britain, Continental Europe and North America.

Out of six tenders submitted that of the Cleveland Bridge and Engineering Company (Limited), of Darlington, England, has been accepted. The firm undertakes to complete the bridge in 22 months, the price being $300,000. The bridge is required to accommodate road and tramway traffic and there will be footpaths carried upon cantilevers on either side, the width of the bridge between parapets being 19 metres. In addition to two approach spans there will be a rolling lift span giving a clear opening for river traffic of 63 metres. The bridge is of a distinctly artistic design, and will be finished in ashlar, drawn from quarries near Cairo.

OBITUARY.

The death is reported of Mr. H. J. Fairweather, electrical engineer in charge of the power-house of the Canadial General Electric Works, at Peterborough, Ont. Mr. Fairweather was drowned while cleaning away ice in the flume. His original home was New Brunswick, where his wife, a daughter of Mr. R. B. Rogers, C.E., and a two-weeks-old baby are at present.

PERSONAL.

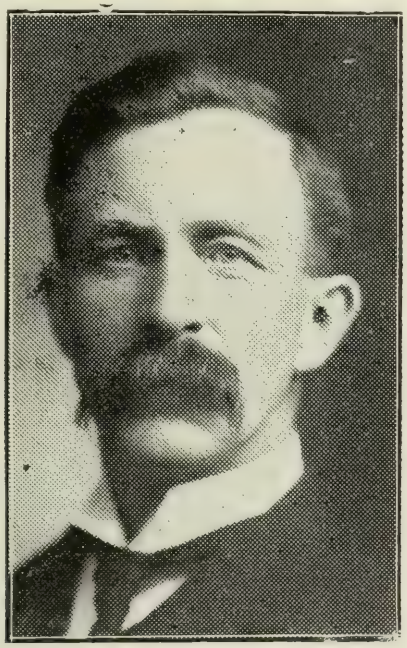
Captain W. C. Hemeon has been appointed harbor master of the Port of Liverpool, province of Nova Scotia.

Mr. E. C. Miller has been appointed Toronto representative of Messrs. T. Pringle & Sons, Coristine Building, Montreal. Mr. Miller will locate his office at 509 Continental Life Building.

Mr. Chas. K. Howard, former travelling freight agent of the Canadian Pacific Railway, with headquarters at Fredericton, N.B., has accepted an appointment with the St. John and Quebec Railway Company.

James Oborne, general superintendent of the C.P.R. at Toronto, has been appointed general superintendent at Vancouver, B.C.

Prof. L. B. Stewart, of Toronto, has been elected president of the Royal Astronomical Society of Canada. Prof. Stewart is professor of Surveying, Faculty of Applied Science, Toronto University. He was one of the first professors



Prof. L. B. Stewart.

appointed on the staff of the old School of Science, which later became the Faculty of Applied Science and Engineering of the University of Toronto. He is one of the few men in Canada who hold the degree of D.T.S. (Dominion Topographic Surveyor.)

Mr. E. Cousins, as announced in last week's issue, has been appointed to the position of engineer to the Commission of Harbors, City or Toronto. Mr. Cousins has been an as-

Mr. E. Cousins.

sistant engineer for Toronto since July, 1910, having had charge of the railway department since his appointment, and of bridges and docks since last February. The plans which he has prepared for the city include the Ashbridge Bay docks, Princess street dock, groynes at Kew and Balmy Beach, sea wall and the underground railways and civic surface lines. He has also had superintendence over the Don industrial tracks, Sunnyside grade separation, Don high level bridge, completion of Wilton avenue bridge, and Weston road viaduct construction.

Mr. Cousins is an honor graduate of the Faculty of Applied Science, University of Toronto.

Mr. W. L. Woodroofe has been appointed to the position of electrician for the city of Vancouver, B.C. Mr. Woodroofe has had considerable experience with the British Columbia Electric Railway.

THE ANNUAL DINNER OF THE FACULTY OF APPLIED SCIENCE, UNIVERSITY OF TORONTO.

The twenty-third annual dinner of the Engineering Society of the Faculty of Applied Science and Engineering of the University of Toronto, was held on January 18th in the Convocation Hall of the University of Toronto, Mr. W. B. McPherson the president of the Engineering Society was in the chair.

A very interesting address on the progress of the work undertaken by the Dominion Conservation Commission was given by Secretary Patton of that body, who came at the request of the chairman, Mr. Clifford Sifton, after the commission closed its annual meeting at Ottawa.

Dr. Ellis responded to the toast of the University, and Mr. W. F. Tye, consulting engineer, and president elect of the Canadian Society of Civil Engineers, responding to that of "The Engineering Profession," gave the students a history of old-time engineering as compared with that of the present, pointing out the difference in the way the profession and the public used to treat graduates of engineering schools and the way they are now treated.

Mr. George Guess, the new professor of metallurgy, was introduced, and spoke briefly. Dean John Galbraith made a short speech on engineering and university topics in general.

Student representatives were present from McGill and Queen's Universities, and among the guests were Mr. W. B. McPherson, K.C., M.P.P.; Mr. P. W. Ellis, of the Toronto Hydro-Electric Commission; Mr. J. W. Tyrrell, the Arctic explorer, of Hamilton; Mr. P. W. Sothman, chief engineer of the Ontario Hydro-Electric Commission; Mr. C. H. Rust, outgoing President of the Canadian Society of Civil Engineers; Dean B. E. Fernow of the University Faculty of Forestry; Engineers J. G. Sing, Willis Chipman, and T. Aird Murray, and Controller Church. The School of Science Orchestra and the science octette gave several selections.

ANNUAL MEETING BUILDERS' EXCHANGE, MONTREAL.

The keynote of the toasts which were proposed at the annual banquet of the Builders' Exchange in Montreal on January 9th, was constructive throughout, covering the building up of the Dominion, of the city, and of the nation. There were present two Cabinet Ministers, the Postmaster-General, Hon. Louis B. Pelletier, and Hon. Dr. Sproule, as well as ex-Postmaster-General Rodolphe Lemieux, the first named urging better transport facilities for the wheat harvest and the formation of a Canadian Lloyds route, while Dr. Sproule deprecated the letting loose of strikes by unions just at the inopportune time, and also took a fling at the trusts.

There were about 180 guests present at the banquet in the Windsor Hotel, under the presidency of Mr. James J.

Ballantyne. Mr. Ballantyne spoke briefly on behalf of the exchange, and made allusion to the hardship suffered by builders in regard to stone coming in. He advocated the raising of the duty, and pleaded that some measure of protection should be given the builders against American contractors.

ELECTIONS OF ROYAL ASTRONOMICAL SOCIETY OF CANADA.

Professor L. B. Stewart, of Toronto, was elected president of the Royal Astronomical Society of Canada at the annual meeting of the society. Dr. W. F. King, C.M.G., Ottawa, was elected honorary president; Mr. J. S. Plaskett, B.A., Ottawa, first vice-president; Dr. A. D. Watson, Toronto, second vice-president; Mr. J. R. Collins, Toronto, secretary; Mr. Charles B. Sparling, Toronto, treasurer; Mr. Lachlan Gilchrist, M.A., Toronto, recorder, and Dr. W. M. Wunder, Toronto, librarian. The executive committee was the same as last year, with the exception that G. Parry Jenkins, F.R.A.S., of Hamilton, was elected to a vacancy. It was announced by the representatives from Guelph that Mr. Henry Westerby, the president of the branch, had presented the society with a six-inch telescope, which is the same size as the one in the tower in the Meteorological Observatory in Toronto.

COMING MEETINGS.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Jan. 24, 25, 26, 1912. General meeting, 413 Dorchester St. West, Montreal. Prof. C. H. McLeod, Secretary.

CANADIAN FORESTRY ASSOCIATION.—February 7th and 8th, 1912. Forestry Convention Meetings held in the Railway Committee Room, Parliament Buildings, Ottawa. Secretary, Mr. James Lawler, Canadian Bldg., Ottawa.

CANADIAN LUMBERMEN'S ASSOCIATION.—February 6, 7 and 8, 1912. Annual Meeting to be held at the same time and place as the Canadian Forestry Association.

CANADIAN NATIONAL ASSOCIATION OF BUILDERS. — The Sixth Annual Convention will be held in Toronto, February 20, 1912.

ONTARIO GOOD ROADS ASSOCIATION.—Annual Convention to be held at Toronto, February 26, 27, 28. Secretary, J. E. Farewell, Whitby.

THE CLEVELAND ENGINEERING SOCIETY.—Regular Meeting, Tuesday Evening, February 13, 1912, Chamber of Commerce Bldg., Cleveland, O. Address by Mortimer E. Cooley, Dean, Department of Engineering, University of Michigan; Subject: "Public Utilities and Their Relation to the Public." Secretary, F. W. Ballard.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King's Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secretary, Mr. Heal, Moose Jaw

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Charles Kelly, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President. Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary, H Mortimer-Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, T. A Starkey, M.B., D.P.H., Montreal. Secretary, F. C. Douglas, M.D., D.P.H. 51 Park Avenue, Montreal.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary, R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

TENDERS PENDING

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Arcola, Sask., schoolhouse	Feb. 1.	Jan. 18.	75
Brantford, Ont., schoolhouse	Jan. 27.	Jan. 18.	75
Calgary, Alta., bridge	Feb. 10.	Jan. 18.	86
Chesley, Ont., public wharf	Jan. 31.	Jan. 18.	75
Grandview, Man., scrapers	Feb. 1.	Jan. 18.	75
Lion's Head, Ont., lighthouse tower	Feb. 5.	Jan. 18.	75
Ottawa, Ont., supply of coal	Jan. 29.	Jan. 18.	75
Ottawa, Ont., iron posts	Jan. 31.	Dec. 21.	68
Ottawa, Ont., contracting machinery	Feb. 26.	Jan. 11.	59
Ottawa, Ont., armory, Fernie, B.C.	Jan. 24.	Jan. 11.	59
Petewawa, Ont., improvements to wharf	Jan. 31.	Jan. 18.	75
Saskatoon, Sask., pavements	Feb. 16.	Jan. 18.	86
Saskatoon, Sask., concrete sidewalks	Feb. 16.	Jan. 18.	86
Toronto, Ont., bridges	Jan. 31.	Jan. 18.	75
Vancouver, B.C., supplies for 1912	Jan. 27.	Jan. 18.	75
Victoria. B.C., schoolhouse	Jan. 31.	Jan. 18.	75
Walkerton, Ont., bridge, Saugeen River	Jan. 23.	Jan. 4.	59
Winnipeg, Man., electric vehicle.	Feb. 1.	Jan. 18.	75
Winnipeg, Man., drawings for government buildings		Dec. 21.	68

TENDERS.

Calgary, Alta.—Plans are being prepared for the building of a new school for South Calgary. The building will be 200 x 140, fireproof, hollow tile and concrete floors. Estimated cost, $150,000.

Fredericton, N.B.—The St. John and Quebec Railway Company contemplate making their first call for tenders for construction work on the St. John Valley Railway about the middle of February.

Galt, Ont.—Tenders will be called for waterworks, 250 k.v.a., 2,200 volts motor, direct connected to centrifugal pump. Specifications prepared by the Hydro-Electric Commission, Toronto.

Hamilton, Ont.—Tenders will be received until February 6th, 1912, for supplying the corporation of the City of Hamilton with the following: Works Supplies—sewer pipe, line, sewer brick, castings, asphalt, creosoted wooden blocks, Portland cement, road oil, gravel, lumber, lead pipe, pig lead, iron pipe, valves, hydrants, and extension boxes. Specifications for above can be obtained at the office of the city engineer, S. H. Kent, city clerk, City Hall, Hamilton.

Hamilton, Ont.—S. H. Kent, city clerk, City Hall, will receive tenders for the various trades in alterations to the City Hall, until January 31st, 1912. Full information obtained at the office of Mills & Hutton, architects, Room 804, Bank of Hamilton Building.

Lajord, Sask.—Tenders will be received until Saturday, February 10th, 1912, for the construction of a two-room two-storey and basement brick school building. Plans and specifications may be obtained from the secretary-treasurer of the Prairie Flower School District No. 989, Mr. A. W. Rogers, Lajord, Sask.

Ottawa, Ont.—Tenders will be received until January 30th, 1912, for the supply of some 210,000 barrels of cement, more or less, required for the construction and maintenance of the various canals of the Dominion, and to be delivered in such quantities at such places and at such times as may be directed. Specifications, etc., can be obtained from the Purchasing Agent of the Department of Railways and Canals, Ottawa. L. K. Jones, Secretary Dept. of Railways and Canals.

Ottawa, Ont.—Tenders will be received by the Dept. of Public Works until February 14th, 1912, for the construction of a wharf at Little Lameque, Gloucester County, N.B. Plans, specifications, etc., can be obtained at the offices of Geoffrey Stead, Esq., Dist. Engineer, Chatham, N.B.; E. T. P. Shewen, Esq., Dist. Engineer, St. John, N.B.; the Postmaster at Lameque, N.B., and at the office of R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received at the Dept. of the Interior, until noon of the 31st day of January, 1912, for the furnishing of iron posts for use on the survey of Dominion Lands, to be delivered as follows:—At Winnipeg, five thousand small and one hundred and fifty large posts; at Edmonton, one hundred and fifty large posts. Forms of tender and detailed information may be obtained from the Surveyor-General of Dominion Lands, Ottawa. P. G. Keyes, Secretary Dept. of the Interior.

Ottawa, Ont.—Tenders will be received until February 15th, 1912, for the construction of a dam and sluiceways below the outlet of Lake Quinze at the head of Maple Rapids, in the Townships of Guerin and Baby, County of Pontiac, Que. Plans, specifications and forms of tender can be obtained at the offices of J. G. Sing, Esq., Dist. Engineer, Confederation Life Bldg., Toronto; J. L. Michaud, Esq., Dist. Engineer, Merchants Bank Bldg., St. James St., Montreal; on application to the Postmaster at Haileybury, Ont., and at the office of R. C. Desrochers, Secretary Dept. of Public Works, Ottawa, Ont.

Ottawa, Ont.—Tenders will be received until February 7th, 1912, for the erection of a public building at Lloydminster, Sask. Plans, etc., may be obtained at the offices of Mr. J. E. Cyr, Supt. of Public Buildings for Manitoba; Post Office Bldg., Winnipeg, Man.; at the Post Office at Lloydminster, and at the office of R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders are being invited by the Department of Public Works for the construction of a pier at Upper Salmon River, Albert County, N.B. Received until Wednesday the 14th of February, 1912. Plans, etc., at the offices of E. T. P. Shewen, district engineer, St. John, N.B..; Geoffrey Stead, district engineer, Chatham, N.B.; the Postmaster at Alma, N.B., and at the office of R. C. Desrochers, secretary, Department of Public Works.

Regina, Sask.—Tenders will be received until Feb. 16, 1912, for the several trades required in the erection and completion of a theatre in the town of Swift Current, Sask. Plans, etc., at the office of Messrs. Sharon & Darrach, Architects, Regina.

Saskatoon, Sask.—Tenders will be received by the City Commissioners until February 23rd, 1912, for the construction of the sub-structure for a subway under the Canadian Northern Railway Company's tracks at 23rd Street, in the City of Saskatoon. (See adv. elsewhere in the Can. Eng.)

Toronto, Ont.—Tenders are being called by the chairman of the Board of Control, City Hall, Toronto, until Tuesday, February 20, 1912, for the supply of track intersections and other special work layouts. (See advertisement elsewhere in The Canadian Engineer.)

Toronto, Ont.—The Temiskaming & Northern Ontario Railway Commission will shortly be in a position to call for tenders for the construction of the extension into the Elk Lake District.

Toronto, Ont.—Tenders will be received, addressed to the Chairman of the Joint Building Committee of the Y.M.C.A. till noon, Monday, February 5th, for the various trades required in the erection of the Central Building, Nos. 30-40 College Street and 35-47 Grenville Street. Burke, Horwood & White, Architects, 25 Toronto St.

Toronto, Ont.—Tenders will be received until Jan. 31st, 1912, for the construction of concrete abutments and a steel bridge, 100 feet clear span, and also for a reinforced concrete truss bridge, 50 feet clear span, over the Burnt River in the Village of Haliburton, Municipality of Dysart. Frank Barber, Civil Engineer. (Adv. in the Can. Eng.)

Toronto, Ont.—Tenders will be received by the Chairman of the Board of Control, City Hall, until noon, Tuesday, Jan. 30th, 1912, for the construction of sewers. (See adv. elsewhere in the Can. Eng.)

Victoria, B.C.—Tenders will be received until the 31st day of January, 1912, for the erection and completion of a gymnasium for the Provincial Normal School, Vancouver, B.C. Plans, specifications, etc., at the office of the Timber Inspector, Vancouver, B.C.; the Government Agent, New Westminster, B.C.; and the Dept. of Public Works, Parliament Buildings, Victoria.

Winnipeg, Man.—The date for delivery of preliminary plans in connection with competitive drawings for the new Parliament Buildings, to be erected in the city of Winnipeg, is extended to March 31st, 1912. Colin H. Campbell, Minister of Public Works. (Adv. in the Can. Eng.)

Winnipeg, Man.—Tenders will be received until February 16th, 1912, for the supply of steel casement sash, linen chute doors and elevator doors, for the King George Isolation Hospital. Plans and specifications may be obtained at the offices of Mr. H. B. Rugh, Architect, 928 Union Bank Bldg. M. Peterson, Secretary Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders for the supply and installation of a five million gallon horizontal turbine pump driven by an induction motor, direct-connected, will be received until March 1st, 1912. M. Peterson, secretary, Board of Control Office, Winnipeg. (See advertisement elsewhere in The Canadian Engineer.)

Winnipeg, Man.—The Winnipeg Public School Board are open to receive tenders until February 8, 1912, for two motor generator sets and two rotary transformers and generators required in connection with the Kelvin and St. John's Technical High Schools. Specifications, etc., at the office of J. B. Mitchell, commissioner of supplies, School Board Office. R. H. Smith, secretary-treasurer, W.P.S.B.

CONTRACTS AWARDED.

Calgary, Alta.—Messrs. Gorman, Clancy & Grindley, of this city, have closed contracts with the city of Moose Jaw for the supply of upwards of 20 miles of 18½-inch steel pipe for the new gravity water system, to be installed by that city very shortly. The same firm also have a contract with the city of Lethbridge for the supply of 14 miles of rails, together with specials and poles for the Lethbridge Street Railway.

Hamilton, Ont.—The Hamilton Bridge Company has secured the contract for the erection of the new buildings for the Steel Company of Canada. Total cost, $140,000.

Lethbridge, Alta.—The contract for street car equipment has been awarded to United States Steel Products Co., 706 McArthur Bldg., Winnipeg. City Engineer, A. C. D. Blanchard.

Montreal, Que.—The contract for offices and stores on Notre Dame and St. Sulpice Streets, has been awarded to Mr. C. E. Deakin, 11 St. Sacrament Street. Cost, $147,000.

Toronto, Ont.—The Electrical Development Company have awarded the contract for the completion of the power house at Niagara Falls, to Messrs. Page & Co., Toronto. Exclusive of equipment, the power house cost over $500,000, and the new addition will cost between $200,000 and $300,000.

Victoria, B.C.—The contract for the completion of the warehouses and other buildings on the new provincial wharf at Prince Rupert, has been awarded by the provincial minister of works to the Westholme Lumber Company, of this city, the successful tender for the work being at a price of $12,550.

Westmount, Que.—Messrs. Mussens, Limited, Montreal, have the contract for the supply of one steam road roller, at a cost of $3,110. Other tenderers were: Messrs. Brennan & Cairnie, Westmount, $2,900; Messrs. F. Hankin & Co., Montreal, $2,600; Messrs. Chambers & Simpson, Toronto, $2,930. Arch. Currie, City Surveyor.

RAILWAYS—STEAM AND ELECTRIC.

Montreal, P.Q.—The estimates of the Canadian Pacific for 1912 are placed at $20,000,000.

Ottawa, Ont.—During the recent investigation into the telegraph department of the Canadian Pacific Railway lines, it was brought out that the total cost was $6,696,421.40, of which $3,897,238 was for line equipment. This was spread over 12,108 miles of poles, making the average cost $321.87 per mile.

Ottawa, Ont.—It is reported that the Grand Trunk Pacific Railway will seek legislation at the present session of parliament empowering the company to issue additional debenture stock perpetual or terminal, up to a total of $25,000,000. The company needs an additional $15,000,000 to complete its railway, to purchase rolling stock and construct branch lines, etc. Mr. Hays preferred to get the money by way of a government loan, as they got $10,000,000 three years ago, but the new government being found to be less indulgent than the old, the company finds a further issue of debenture stock necessary.

Ottawa, Ont.—The Dominion Railway Commission are preparing a measure to eliminate several level crossings or install certain safety devices.

Ottawa, Ont.—It is reported that a deputation representing an English syndicate has asked for consideration of the charter of the Hudson Bay Pacific Railway Company. This charter was granted in 1906 for the building of a road from Prince Albert to Churchill, but no work was done; the charter, it is understood, has now fallen into the hands of English capitalists, who are asking for the guarantee of their bonds for the carrying out of the project.

Port Arthur, Ont.—The council will apply for legislation to extend the street car system to districts outside the city boundaries.

Toronto, Ont.—Toronto is to be the head office of the Mexican Interurban Electric Traction Company, Ltd., which has been incorporated with a capital stock of $5,000,000. A number of Toronto men are associated with Dr. Pearson, of New York, in the enterprise, among whom are Mr. Z. K. Lash, K.C., vice-president of the Mexico Tramways Company.

Vancouver, B.C.—Property owners are to appeal the offer of the Great Northern Railway for their lots on False Creek. The property owners were given $1 each for their property. The owners first sought a total of $57,000 damages, or an average of $3,000 per lot. The award of the arbitrators of $1 apiece is declared to be far from equitable.

LIGHT, HEAT AND POWER.

Brantford, Ont.—The committee appointed to investigate the possibility of a reduction in the cost of electrical energy, have decided to extend an invitation to the hydro-electric engineers for a report. The contract with the Ontario Power Company does not expire for 27 years yet. A rough estimate from the hydro-electric states that a transforming station to supply 1,500 horsepower, could be erected at a cost of $70,163.

Galt, Ont.—Galt will soon be calling for tenders for a cynchronous motor 250 K.V.A. 2,200 volts, 750 R.P.M., to be used on the waterworks. J. H. Radford, Chairman Waterworks Commission.

Long Sault Rapids, St. Lawrence River.—It is reported that Mr. W. J. Westley, of Morrisburg, has gone to Washington in an effort to overcome certain difficulties in connection with this development.

Niagara Falls, Ont.—A representation from Buffalo, Niagara Falls, N.Y., and Detroit have urged the house of foreign affairs at Washington, D.C., to change the limit of diversion of water on the American side from the present, 15,600 cubic per minute, to the maximum of 20,000 feet as

Charles Street, Stratford, Ontario, showing "Tarvia Modern Pavement."

Stratford's Experience with Tarvia

STRATFORD, Ontario, did some thorough and successful work with Tarvia X in 1910 and the accompanying photograph shows a section of Charles Street in that city built by the Tarvia Modern Pavement Method.

Tarvia X was used as a binder throughout the road on a Telford base. Although the job was done by the somewhat primitive barrel-and-kettle method, the total cost was only $1.32 per yard.

The Tarvia, filling the voids of the stone, acts as a plastic matrix, keeping the stone in position, preventing all internal movement, resisting water and frost, protecting the road against automobile traffic and preventing the formation of dust.

After its first year of use, the street is in excellent condition and is giving perfect satisfaction. It has been visited by various engineers, all of whom agree as to the success of the work.

This is only one of thousands of instances of successful Tarvia construction.

We will be glad to send to any inquirer a booklet showing many other cases.

The Paterson Manufacturing Co., Limited
Montreal Toronto Winnipeg Vancouver

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St. John, N.B. Halifax, N.S.

authorized by the treaty. They also seek the removal of the present limitation of 160,000 horse-power, that may be imported from Canada.

North Toronto, Ont.—The Water, Fire and Light Committee have recommended that the town council install a motor generator and storage battery system for the fire alarm system. This is to cost $2,000. Mr. E. A. James, Engineer.

Port Stanley, Ont.—It is expected that the hydro-electric line into Port Stanley will be completed in a few days.

Quebec, P.Q.—A new power company, capitalized at $1,000,000, has been formed in Quebec, with Hon. L. P. Pelletier as president. It will be known as Stadacona Light, Heat and Power Company.

Toronto, Ont.—A legal decision of interest to engineers and power house managers, was handed down by Mr. Justice Riddell and two other judges. Their decision allows the Canadian Niagara Power Company to pay for excess power, besides the yearly rental of $15,000, on an average basis, instead of on the individual excess, or "peak load" basis, without regard to times when the power used might be under the limit.

SEWAGE AND WATER.

Calgary, Alta.—The city engineer has recommended that the reservoir be lined along the bottom and sides.

North Toronto, Ont.—The Water, Fire and Light Committee have recommended to the council the sinking of a well to cost $1,500, also that weeping tiles be placed, in order to increase water supply. Mr. E. A. James, engineer.

Ottawa, Ont.—The new intake pipe will be coupled up in from three to four weeks, according to the city engineer. There is about 120 feet to be laid as yet.

Ottawa, Ont.—The engineering firm of Siemen Brothers, London, England, are sending a representative to Ottawa to prepare a report on the water supply question.

Port Arthur, Ont.—The question of securing a municipal water supply from Loch Lomond is again before the council.

Richmond, B.C.—This municipality is preparing a by-law to borrow the sum of $50,000 for the construction of waterworks.

Regina, Sask.—The municipal council intend to make a test within the next few days to ascertain just what water pressure can be maintained and to find out if the supply of water is sufficient for the requirements of the city.

Saskatoon, Sask.—A private corporation which enjoys the privilege of supplying the outlying districts of Saskatoon with water have raised their price to 25c. per barrel. The council are investigating for a reason.

Victoria, B.C.—The city council on the recommendation of the water commissioner decided to purchase 10,000 feet of ten-inch pipe, 10,000 feet of eight-inch pipe, 50,000 feet of six-inch pipe, and 50,000 feet of four-inch pipe at a cost of $55,000. In addition there will be purchased 1,220 water meters of the Trident type at a cost of $17,670. Angus Smith, city engineer.

Weston, Ont.—The council has decided to go ahead with installation of sewage disposal plant. T. Aird Murray of Toronto has been called in as consulting engineer.

BUILDING.

Brantford, Ont.—The Dominion Government have purchased a site on Dalhousie Street on which to erect a $200,000 post office.

Calgary, Alta.—A report states that the Swift Packing Plant of Chicago will erect a branch in Calgary.

Calgary, Alta.—The city engineer, Mr. J. F. Childs, has drawn up an estimate of the cost of providing the city with an asphalt plant, which would be in the neighborhood of $20,000.

Calgary, Alta.—The Canada Malting Company will begin construction work at an early date. This plant will have a capacity of 750,000 to 800,000 bushels per year. They will erect a large elevator, which will have a capacity of 400,000 bushels. The estimated cost is $250,000.

Coquitlam, B.C.—Messrs. Brown & McKay, an eastern firm, are reported to have arranged the purchase of a site for the construction of a steel works to cost $100,000. They have bought a site for a woodworking plant.

Fort William, Ont.—Certain technicalities in connection with the granting of warehouse sites have been overcome. Some of the concerns contemplating building operations in 1912-13 are: The Cameron Heap Company, Fort William; The McLaughlin Biscuit Mfgs., Fort William; The Fife Hardware Company, Fort William; The Fitzsimmons Fruit Company, Fort William; Matthews Pork Packing Company, Fort William; Tees and Peiss of Winnipeg.

Galt, Ont.—A new lighting system is to be installed in the Baptist Church. Mr. S. Misner is financial secretary.

Montreal, P.Q.—The British-Canadian Canners, Ltd., have secured sites for five factories and plan to erect factories this year. The sites are located at Merlin, Highgate, Port Robinson, Bowmanville and Cobourg. Contracts for buildings and machinery, it is reported, will be called for at an early date. The directors of the British-Canadian Canners, Limited, comprise Sir Henry N. Bate, of Ottawa, and J. P. Black, H. A. Lovett, K.C., and R. Brutinel, of Montreal.

Moose Jaw, Sask.—The Jensen Tanneries, of North Dakota, U.S.A., are negotiating with the municipal council for a site on which to erect a $15,000 plant.

Nanaimo, B.C.—The $50,000 School Loan By-law to sanction the borrowing of a sum of money not exceeding $50,000 for the erection of a new school was carried.

North Vancouver, B.C.—The Vancouver Safe Works, Ltd., are considering establishing a plant on the North Shore. The company contemplate taking out a 10 to 20-year lease on two acres of land for the erection of a plant and equipment to cost approximately $50,000, which would give employment to about fifty men.

Oshawa, Ont.—The government have decided to construct an armory, providing the town council supply a suitable site.

Port Arthur, Ont.—The congregation of St. Paul's Presbyterian Church have decided to erect a building to cost $40,000 or $50,000. A committee consisting of L. Walsh, M. Hood, M. W. Bridgman, A. M. Long, F. Urry and L. J. McCutcheon have been appointed to undertake the preliminary work of getting out plans, etc.

Port Arthur, Ont.—Acting for Mackenzie & Mann, and a British syndicate, J. M. Fraser, of the Atikokan Iron Co., submitted to the city an application for the establishment of a $5,000,000 steel plant. The city will give a site of 400 acres at Bare Point and a fixed assessment for twenty years of $50,000 except for school and local improvements.

Port Arthur, Ont.—Mr. D. K. Campbell will erect a 4-story hotel on Arthur St. at a cost of $50,000.

Regina, Alta.—The Rock City Tobacco Company of Quebec, P.Q., have decided to construct a new warehouse in this city, providing a suitable site may be secured. Mayor Drouin of Quebec is president of this company.

St. Catharines, Ont.—The Dominion Government have increased the estimates for this locality by $6,000 for repairs to a bridge at Lock 4, old canal. The estimates for the Welland Canal in addition to the above are: $3,000 for a bridge over the feeder canal, $10,000 for heavy repairs, $8,000 for installing Gowan Safety devices, and $15,000 for the repairing of foundations of locks on the old canal.

Toronto, Ont.—Mr. P. J. Mulqueen, proprietor of the Tremont House, has obtained a permit to erect a hotel structure to cost $80,000. Work is to start about April 1st, 1912.

Toronto, Ont.—The estimates for the property and street cleaning department include $85,000 for firehalls at Wright and Roncesvalles, at Greenwood Avenue, and at St. Clair and Hendrick Streets; $30,000 for a bath house on a site to be acquired from the Harbor Commission, and $26,000 for lavatories. The increase in maintenance over last year is $32,000.

Vancouver, B.C.—There is considerable likelihood of a new city hall being erected. The cost of this is to be $750,000.

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PLUNGER. —Our plunger elevators embody patented features such as a new main valve which prevents bounding when the car stops, and a new control valve which prevents any accidental movement of the car in the opposite direction when passengers are entering or leaving.

ELECTRIC. —Our electric elevators have patented improvements embodying the good features of the drum and traction type and eliminating their bad ones, and giving greater security and economy of operation. These elevators are worthy of the attention of all interested in office and factory building.

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For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

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The aldermen suggest that competitive plans be sought from architects. The intention is to construct a permanent city hall of architectural beauty, and so laid out that wings could be added to it if necessary later on, as the site is ample for city hall needs for many years.

Victoria, B.C.—It is reported that the estimates of Hon. Thomas Taylor, provincial minister of public works, contain an item of $7,000,000 for new roads and public bulidings throughout British Columbia.

ROADS AND PAVEMENTS.

Ottawa, Ont.—Premier Borden is to receive a deputation from the Ontario Motor League, who will urge on the Federal Government the necessity of maintaining good roads in the Province of Ontario and of making grants towards the same.

CURRENT NEWS.

Esquimalt, B.C.—Twelve carloads of steel plates and tank material have arrived for use in the alterations being made to the G.T.P. liner Prince George. The steamer is being equipped to burn fuel oil at the British Columbia Marine Railway Company's yards. It was necessary to construct special tanks in the steamers to contain the supply of oil.

Latchford, Ont.—An acetylene explosion occurred in the rear of the King Edward Hotel. Considerable damage to property resulted.

Ottawa, Ont.—The Dominion Government have decided to restore the bounties on pig iron.

Ottawa, Ont.—A deputation representing the iron and steel industry waited on the government in an effort to obtain from the new government the restoration of the iron and steel bounties and further encouragement for the iron industry.

Ottawa, Ont.—The statement of the municipal treasurer shows a deficit of $78,085. The treasurer's statement is as follows:—

Deficit in city general account, excluding $12,500 for extra land for Lady Grey Hospital, for which debentures are to be issued		$68,163.72
Deficit, interest and sinking fund account		1,705.45
Deficit, street watering		5,071.11
Total deficit		$74,940.28
Less surplus in hospital account	$ 3,882.70	
Net deficit, exclusive of waterworks	$71,057.58	
Waterworks deficit	7,028.00	
Total net deficit		$78,085.58

Province of British Columbia.—The penalties imposed by the timber branch of the Department of Lands for the year 1912 amounted to $13,199. The total timber branch revenue for the province for 1911 amounted to $2,297,452.25.

Province of New Brunswick.—A deputation from New Brunswick are at Ottawa seeking to have an experimental farm established in that province.

Province of Alberta.—The use of a common drinking cup in this province is now against the law.

Province of Manitoba.—At the next session of the legislature there will be inaugurated a "Public Service Commission" for the province. Under this commission will be placed all the public services of the province, including steam and electric railways, gas and electric lighting, telegraphs, telephones, grain elevators and any other public utility.

St. Boniface Man.—A plan to reclaim certain lands now occupied by the River Seine is being prepared for discussion by the municipal council. The plans show a cutting off of the Seine south of the city boundary, and a short cut to the Red River about opposite River Park. An alternate plan shows a cutting of the stream at the St. Boniface Road, which is the southern boundary of the city. Here it is proposed to run the water through a flume in the centre of the road to a point in the Red River shore opposite Bartlett Avenue, Fort Rouge. The ground thus saved is desirable for railway purposes, as yards, and the filling in of the creek would obviate the necessity of bridges. All the railways will be able to use the territory, and new tracks laid east from Winnipeg will be opposed by no such difficulties as are now to be met. The lands are valued at approximately $3,000 per acre.

Toronto, Ont.—The Works Committee have recommended the municipal council to discontinue its policy of insuring laborers against accident, as premiums have amounted to $7,191.73 per annum, and accidents have been fortunately few.

Vancouver, B.C.—Amongst the suggestions made by Mr. Lea, the engineer preparing the plans for the sewage system, was that the city should provide him with an assistant resident engineer to secure data regarding surfaces, make the further investigations as to areas, and report to him. The commission passed a resolution authorizing the chairman to consult with Mr. Lea as to the selection of an engineer.

Winnipeg, Man.—It is the intention of the municipal authorities to construct a submarine telephone cable across the Red River.

Winnipeg, Man.—The faculty of the University of Manitoba has arranged a series of lectures to be given during the month of February. The syllabus is as follows: "The Pitch and Quality of Musical Sound," "Experiments on Flame," "The Mineral Resources of Manitoba," "Water Purification."

Winnipeg, Man.—The Minister of Public Works announces that the time for receiving competitive drawings for the new parliament buildings has been extended to March 1st, 1912.

BUSINESS.

Dauphin, Man.—Fire did considerable damage to the Canadian Northern Railway station at this point. The telegraph office was destroyed.

Kenora, Ont.—Fire destroyed the fire hall, police station and a business block. The damage is placed at $50,000.

Kingston, Ont.—The municipal council are about to consider the installation of a heating system for the city hall, to replace the box stove method now in use.

Medicine Hat, Alta.—There is a probability of the Ogilvie flour mill coming to this city, and negotiations are in course of progress between the municipality and a representative of the company. The head office of this company is in Montreal, P.Q.

Montreal, P.Q.—$125,000 damage was caused by fire to the building and contents of the Richelieu and Riendeau hotels, and the Hobb Glass factory.

Port Stanley, Ont.—It is stated that the Dominion Government will erect a fish hatchery at this point in the near future.

Port Arthur, Ont.—The fire, water and light committee have been instructed to purchase a new fire engine of not less than 600 gallons capacity.

St. Mary's, Ont.—$10,000 damage was caused by fire to the plant of the St. Mary's Wood Specialty Company. The sawmill and part of the main building were destroyed.

Shoal Lake, Man.—A loss of $25,000 was caused to the business district of Shoal Lake.

St. Boniface, Man.—The plant of the Winnipeg Steel Granary and Culvert Company, in the outskirts of St. Boniface, was totally destroyed by fire with a loss of $15,000.

Sudbury, Ont.—The Canadian Copper Company's hospital was destroyed by fire. The loss is estimated at $50,000.

Toronto, Ont.—Fire damaged the R. D. Fairbairn & Company and the Allen Manufacturing Company's building to the extent of $250,000.

Toronto, Ont.—The Dominion Foundry at 400 East Front Street, owned by Messrs. Blatchford & Trelour, was damaged to the extent of $10,000 by fire.

Winnipeg, Man.—$100,000 damage was caused by fire to the plant and building of the Winnipeg Cold Storage Co.

Winnipeg, Man.—Damage of $20,000 was caused by fire to the Lightfoot furniture storage warehouse.

Heat and Oil-Resisting Steam Hose

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Steam and Hot Water Hose

Dependable Hose for Boiler Rooms

This hose is *specially treated* to yield the maximum resistance to steam and *oil*—agencies that play havoc with other hose, *shortening its usefulness and doubling its cost.* The toughest, strongest, least-affected-by-heat hose in existence — and the most economical.

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Air Hose
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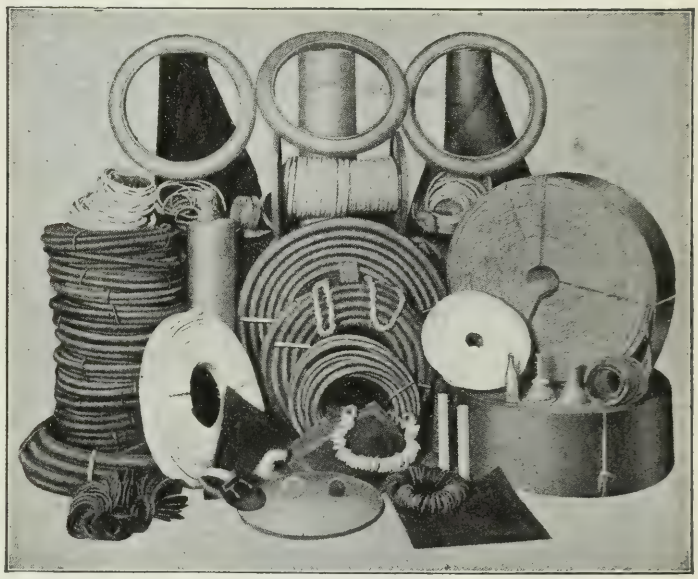

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ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

15748—January 4—Authorizing C.N.O. Ry. to cross public road, Twp. of Nelson, County of Halton, Ontario.

15749—January 3—Authorizing City of Winnipeg to extend Ellice Avenue across C.P.R. Pembina Branch.

15750—January 3—Approving location of South Ontario Pacific Ry. station at Progresston, mileage 5.32, Twp. of East Flamboro, Ontario.

15751—December 14—Directing that G.T.R. employ watchman from May 1 to October 1 of each year at crossing just east of Grimsby Beach, Ontario; 15 per cent. by Twp. of Grimsby, remainder by G.T.R.

15752—January 3—Extending until June 1, 1912, time for making changes by G.T.R. to water standpipes at Alexandria, Ont.

15753—January 11—Approving plans for spur track to property of W. H. Haight, Piper's Siding, B.C., G.N.R.

15754—January 8—General Order re Freight Rates Western Canada.

15755—January 8—Authorizing C.P.R. to construct spur for Bardsley and Peterson in N.E. ¼ Sec. 4, Twp. 2, R. 7, W. 2 M.

15756—January 8—Authorizing G.T.R. to construct spur for Lautz Co., village of Bridgeburg, Ontario.

15757—December 28—Directing Atlantic, Quebec & Western Ry. to provide farm crossing for Arsene Lelievre, Little River East, joint crossing with A. Shannon. See No. 15456, November 22, 1911.

15758—January 8—Authorizing C.N.O. Ry. to construct its line from present tracks of Central Ontario Ry. at Stanley Street, Trenton, Ont., to railway bridge across Trent River.

15759—January 8—Naming express collection and delivery limits for City of Strathcona, Alta.

15760—January 4—Authorizing C.P.R. to divert road allowance in Twp. of Mara, County Ontario, mileage 41.56 from Victoria Harbor.

15761-62—January 4—Authorizing C.N.O. Ry. to take of Geo. W. Burgess and John Penny, in City of Belleville, Ont.

15763—January 8—Authorizing G.T.P.B.L. Co. to cross with its Melville-Regina Line public road at mile post 42, Lebret, Sask.

15764—January 9—Directing that crossing over Yonge Street, Simcoe, Ont., G.T.R., that when watchman is not on duty that crossing be protected by flagman for all switching movements.

15765—January 5—Directing C.N.R. to complete by February 15, 1912, under penalty of $10 per day to erect wind breaks, etc., just east of Melfort, Sask. Complaint L. I. District, 428 South Melfort, Sask.

15766—December 13—Approving plans for new station by G.T.R. at Stoney Point, Ont., station at new location.

15767—January 3—Authorizing C.P.R. to cross with its Swift Current to Brooks Branch twenty-three highways in Saskatchewan.

15768—January 11—Authorizing C.P.R. to construct sidings into Union Stock Yards, at Toronto, Ont.

15769—January 9—Authorizing C.N.O. Ry. to open for carriage of traffic its line from Harrowsmith to Sydenham, mileage 160.50 to 163.50 from Don Junction, Ont.

15770—January 11—Authorizing Government of Saskatchewan to divert highway and cross C.P.R. at Foam Lake, Sask.

15771—January 9—Authorizing G.T.P.B.L. Co. to cross with its Melville-Regina Branch highways and to divert same at mileage 85.9 and 58.9, Saskatchewan.

15772—January 9—Authorizing T., H. & B. Ry. to discontinue operation of its interlocking appliances at crossing of Hamilton Street Ry. Co. at Barton Street East, Hamilton, until May 1, 1912, crossing to be protected by flag during passage of trains.

15773—January 11—Authorizing C.P.R. to operate spur into premises of Lowe Bros., Sorauren Avenue, Parkdale, Toronto, Ont.

15774-75—January 10—Extending until March 31 and May 31, 1912, time for completion by C.P.R. of subways at point in Sec. 34, Twp. 24, R. 2, West 5, M. and at Jane Street, West Toronto, Ont.

15776—January 12—Approving Lachine, Jacques-Cartier & Maisonneuve Ry. Co. location 400 feet west of C.P.R. crossing at Iberville Street to terminal at St. Catharine Street, Montreal, through lands of C.P.R., subject to agreement between the two companies.

15777—January 8—Directing that before June 15, 1912, the C.P.R. provide an interchange track with G.T.R. in town of Goderich, Ont.

15778—January 9—Naming express collection and delivery limits for town of Brigthon, Ont.

15779—January 10—Directing Canadian Express Co. to file tariff before January 25, 1912, abolishing extra charge between Pictou, N.S., and Charlottetown, P.E.I., except where it shall be necessary (owing to weather conditions) for traffic to be carried to Georgetown, P.E.I.

15780—January 4—Directing C.P.R. to not later than February 10, 1912, institute by providing two passenger trains a day each way between Ottawa and Prescott. Complaint Hon. J. D. Reid.

15781—January 8—Authorizing C.N.R. to cross with its Vegreville-Calgary Branch over tracks of C.P.R. McLeod Branch in S.W. ¼ of Sec. 11, Twp. 24, R. 1, West 5 M., Alta., by means of overhead bridge.

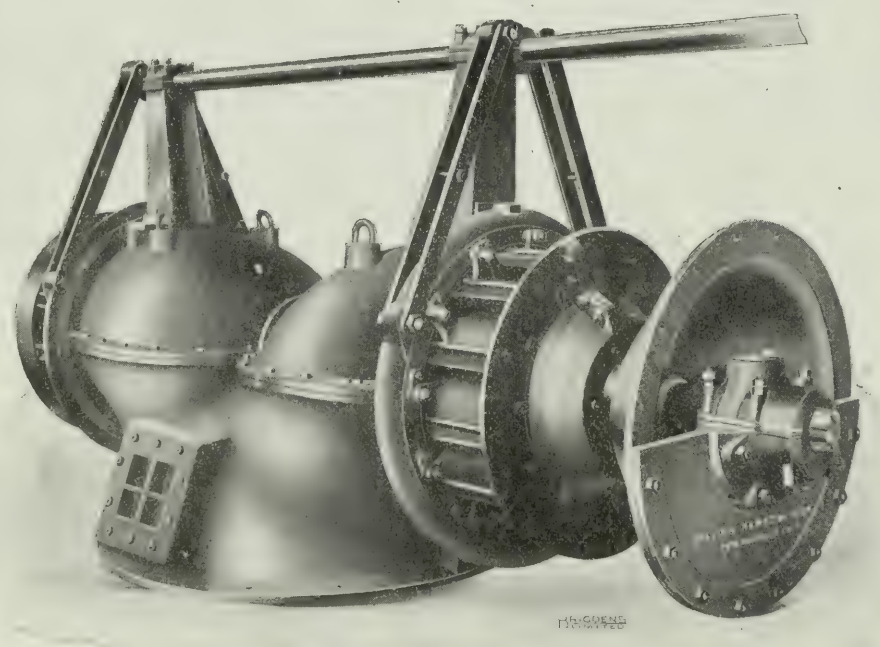
15782—January 9—Authorizing N.Y.C. & H.R.R. to reconstruct interlocking plant at crossing of G.T.R. at Cecile Jct.

15783-84—January 8—Granting certificate correcting omissions and errors in plan of G.T.P.B.L. Co. location, Regina-Boundary Branch.

15785—January 10—Authorizing C.P.R. to construct its Wilkie to Anglia Branch across twelve highways, mileage 0 to 19.37, Saskatchewan.

15786—January 10—Authorizing G.T.R. to construct siding into premises of International Varnish Co., Ltd., and Pinchin, Johnson & Co. (Canada), Ltd., Toronto, Ont.

15787—January 10—Authorizing T., H. & B. Ry. to construct five spurs in City of Brantford, into lands of Verity Plow Co., Ltd., through lands of the New England Co.



Water Wheel Installations

for all power purposes

WILLIAM HAMILTON COMPANY, Ltd., Peterborough, Ont.

Volume 22. Toronto, February 1, 1912

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The Canadian Engineer

An Engineering Weekly

STRAIN MEASUREMENTS OF STEAM BOILERS.

Two 72-inch boilers which had been in active operation for 27 years were contributed for investigative purposes by the late Nicholas Sheldon, treasurer of the Kendall Manufacturing Company, of Providence, R.I. They were made by the Whittier Machine Company, of Boston, Mass., out of "Benzon" steel, were put into service in March, 1881, and had never required repair or renewal in any part. They were made in five courses, two sheets to a course, and had the following general dimensions:

Diameter	72 in.
Length, over dry sheet	16 ft.
Thickness of shell	⅜ in.
Thickness of heads	½ in.
Number of tubes	140
Diameter of tubes	3 in.
Length of tubes	15 ft.
Diameter of dome	2 ft. 6 in.

Longitudinal seams, double-riveted lap joints, ¾-inch rivets, 2-inch pitch, punched holes, rows 2⅜ inches apart, rivets staggered.

Girth seam, ¾-inch rivets, 2⅛-inch pitch.

Heads stayed, each, with 14 braces.

Cast-iron manhole frames and safety-valve nozzle.

Supported by lugs, three on a side.

The feed-water came from the Pawtucket river.

The utmost advantage of this opportunity was secured by placing in charge of the tests James E. Howard, qualified by long years of service as the head of the government test-

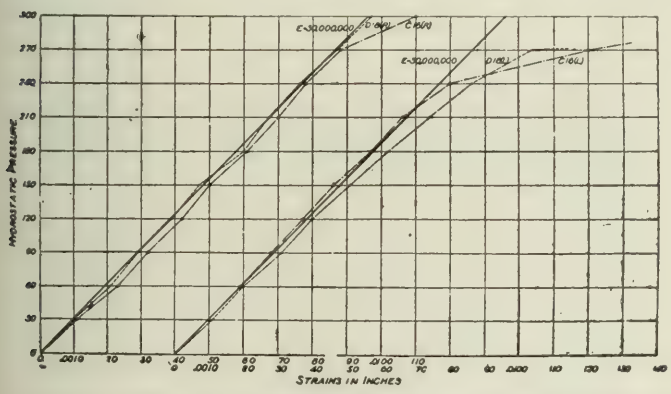

Fig. 1.—Curves of Tangential Extension, Solid Sheets, at Middle of Length of Courses.

ing plant, at the Watertown arsenal and now engineer-physicist of the Bureau of Standards, at Washington. He was advised and assisted by Francis B. Allen, vice-president of the Hartford Steam Boiler Inspection and Insurance Company. The tests were made at the W. H. Hicks Boiler Works, Providence, and form the subject of a paper to be presented at the December meeting of the American Society of Mechanical Engineers, from which the following information is derived:

The tests were made by subjecting the boilers to hydrostatic pressure and measuring the deformation at various points. For this purpose holes about 0.05 inch in diameter and 0.10 inch deep were drilled 10 inches apart in various portions of the shell, and reamed with a reamer having an angle of 65 degrees. A 10-inch strain gauge having conical points with an angle of 55 degrees, adjustable with a micrometer screw, was used to measure the distances between these holes as they varied under stress. The difference in

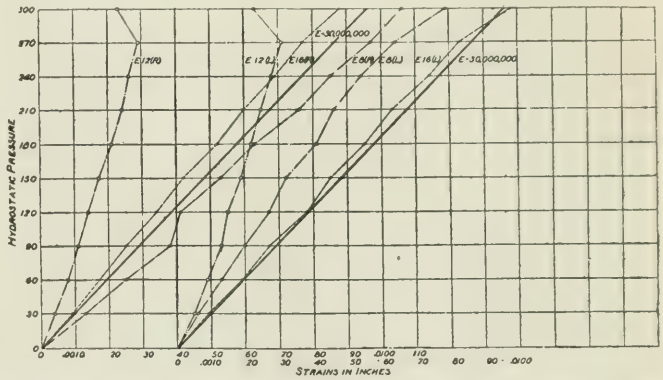

Fig. 2.—Curves of Tangential Extension, Solid Sheets, End Course Near Rear Head, Girth Seam and Middle of Length of Course.

angles made the gauge bear near the surface of the sheet and it is believed that the readings are reliable to $\frac{1}{10,000}$ inch. The stress which would produce an elongation of this amount in a distance of 10 inches is 300 pounds per square inch, assuming a modulus of elasticity of 30,000,000 pounds; that is, supposing that the stress per square inch divided by the stretch per inch of length would equal 30,000,000.

The boilers tested were of a very simple type, yet in very few instances were strains developed corresponding to those which would be indicated by the usual calculation for strains in a cylindrical shell subjected to internal pressure.

In Fig. 1 are laid off in a horizontal direction the amounts of stretch which would be produced by various pressures per square inch in a plain cylinder and with a modulus of elasticity of 30,000,000, each at a height corresponding to the pressure required to produce it. A pressure of 60 pounds per square inch in the interior of a cylinder of this diameter and thickness of shell would, for instance, produce a stretch of nearly 0.0020 inch in a length of 10 inches; and a pressure of 300 pounds a stretch of about 0.0095 inch. The points so determined would lie in the heavy straight line of the diagram marked E = 30,000,000. The distortions actually found were set off in the same way and connected by the lighter lines. They show the extensions of the third and fourth sheets of the boiler, counting from the front on the right and left sides of the boiler respectively, taken at the middle of the lengths of the courses. The courses are lettered A, B, C, D, E; C—16 R. on the diagram means gauged length 16 on sheet C, right-hand side. These follow

the heavy reference line for the ideal condition quite closely upon one side of the boiler, but the leaning to the right of the plotted lines of the other diagram indicates more than a normal stretch.

The strains produced at the various places measured are plotted in this way and the diagrams accompany the paper. E-8 was taken near the girth seam between this and the next sheet and E-16 in the centre of the rear sheet close to, but not spanning, the longitudinal joint. Diagrams of the boiler are given in the paper showing the location of each of the spans measured. Fig. 3 shows the extension across the longitudinal seam on the middle course, curve C-7 being taken at the front edge, C-11 at the rear edge and C-15 in the middle of the sheet. The author points out that in the case of a three-course boiler with one sheet to a course, as found in current construction, it would seem that a double riveted lap joint might occasion (by reason of the greater extension) an excessive stress in the solid sheet abreast the end of the seam, under certain pressures.

Pressure on the exterior of the tubes necessarily extends them in length. The amount of the extension appears to depend upon their position with reference to their proximity to the shell. Tubes adjacent to the shell extend less than those at the middle of the rows, a restraining influence from the shell appearing to affect the outer ones.

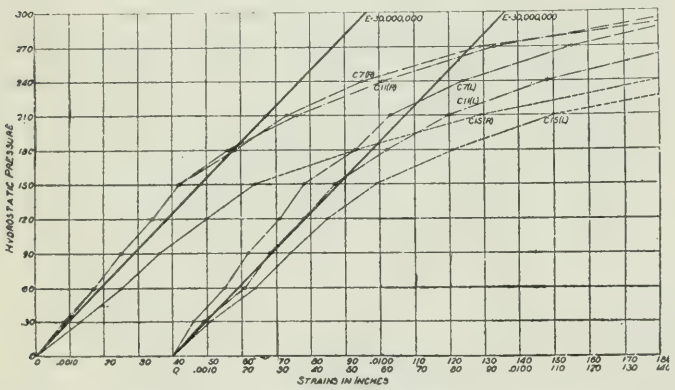

Fig. 3.—Curves of Tangential Extension, Across Longitudinal Seams, at Middle of Length of Course and at Edges.

In a plain cylindrical shell, increase in diameter would necessarily be attended by a definite amount of endwise contraction, eliminating the effect of pressure on the heads. The tests showed that there were parts of the boiler which were nearly free from longitudinal strains, while there were other places in which the strains were reversed and longitudinal extension shown instead of contraction. Along the lower quarter of the boiler the longitudinal strains were contractions, while along the upper quarter they were in part contractions and in part extensions. Figs. 4 and 5 show the amount and character of these strains at 270 pounds in the middle of the sheets and across the girth seams respectively.

It will be noticed that the lower part of the shell contracted notwithstanding the fact that the tubes were extended by the exterior pressure to which they were subjected. This behavior calls for bending at the flanges of the heads to compensate for the difference of these movements. The six through braces would relieve the shell of a portion of the longitudinal tension coming from the heads in the upper half of the boiler. Longitudinal gauged lengths on the upper part of the shell showed diminished contractions over those observed on the lower portion or displayed strains of extension. On the very top of the boiler the strains were extensions of a pronounced order.

The tests for which the figures and diagrams in the paper are given were made upon only one of the boilers. In the tests of the first boiler greater strains were displayed in the vicinity of the dome and the manhole frame than at other parts of the shell, which resulted in an early failure at these places. Actual rupture of the dome was not accomplished, but leakage along its single-riveted longitudinal seam became so great at 266 pounds that it was necessary to remove the dome and close the opening to it in the shell with a patch in order to reach higher pressures with the pump available.

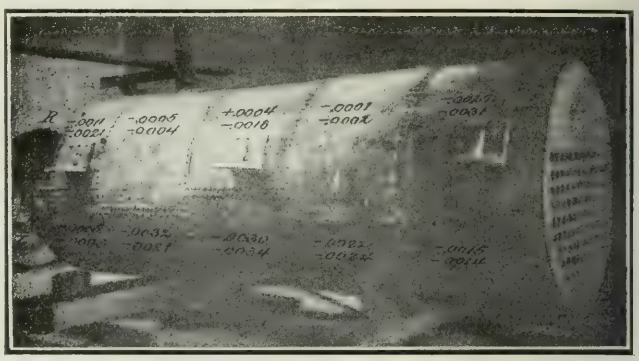

Fig. 4.—Longitudinal Strains on Solid Sheets at Middle Length of Courses. Minus Signs Indicate Longitudinal Contraction; Plus Signs, Longitudinal Extension.

At 270 pounds the cast-iron manhole frame fractured across the middle of its length. Another patch was then put on the shell covering the manhole and the test resumed, when at 295 pounds the rupture of three braces of the front head occurred. The test was then discontinued and the boiler dismantled. The strain measurements made upon the boiler were of the same order as those reported for the second and the results were similar.

A feature, however, in the test of the first boiler was absent or obscure in that of the second. Measurements of strains across the longitudinal seams increased progressively in passing from the front to the rear end of the boiler. The author says: "While these seams were not directly exposed to the heated gases over the grates, nevertheless it seems probable that a wider range of thermal conditions prevailed

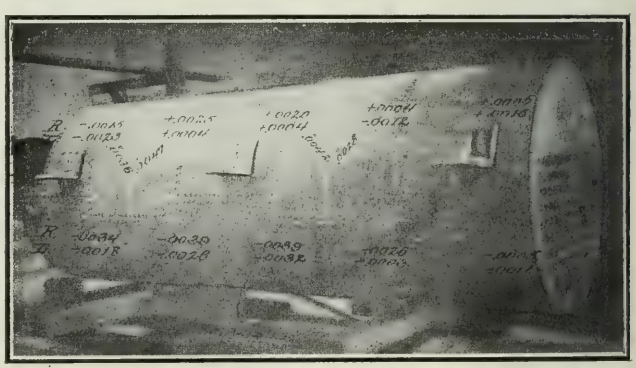

Fig. 5.—Longitudinal Strains Across Girth Seams, Also Strains on Diagonal Gauged Lengths of Courses.

in the vicinity of seams at the front end over those at the rear end of the boiler. If such was the case it would aid in explaining the greater slip of the forward seams." Leakage at the longitudinal seams began at 120 pounds and became general at 180, but at this time the slip of the joints had become pronounced and necessarily disturbed the calking.

The second boiler was stripped of its dome and manhole frame and the openings covered with patches before it was

tested. The heads were strengthened by means of six 1¼ inch through braces. The cast-iron safety-valve nozzle was allowed to remain in place, but was eventually replaced by a soft patch after 300 pounds pressure had been applied and released, as the distortion of the shell under the flange of the nozzle caused leaks impracticable to calk. During the test the boiler was supported on two wooden shoes sawed to fit the curvature of the shell.

When the pressure in the boiler was increased from 300 pounds, the highest indicated on the diagrams, to 335 pounds the manhole patch ruptured. Three of the rivets were sheared by the tangential stress of the shell followed apparently by the fracture of other rivets by tension on their stems which pulled off the heads and finally tore the sheet longitudinally along its upper element, starting this fracture at a rivet hole of the manhole as shown in Fig. 6.

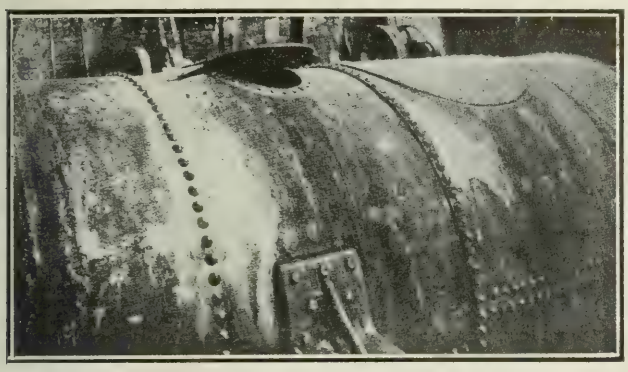

Fig. 6.—Manhole Patch After Rupture.

The shell was repaired by cutting out a portion of the middle course and putting in a section the full width of the course and about 3 feet wide measured on the arc. This was double riveted to the shell at its longitudinal seams. The hand-riveted seams extended rapidly, and copious leaks were started so that at the time of writing the paper no greater pressure than that of 335 pounds, at which the manhole patch ruptured, had been attained.

In summing up, the author points out the usual influence of longitudinal seams in intensifying the stresses in the adjacent sheets, the excessive stress developed at the side of the manhole patch and at the side of the safety-valve nozzle, and suggests that if such abnormal stresses can occur with so simple a structure as the boiler under consideration, it might be well to apply this method of examination to the strains produced in boilers of more complex construction.

GREASE IN GARBAGE.

Grease in garbage at Toronto was determined by a test made in January, 1911, at the works of Messrs. W. Harris & Company, under the direction of Messrs. Hering & Gregory, consulting engineers, of New York City. The object of the experiment was to ascertain by means of the reduction process the amount of grease contained in samples of Toronto garbage. Ten loads of garbage and rubbish, having a total weight of 11,075 lbs. were delivered at the works. This material was sorted over and the rubbish removed from it, leaving a net weight of 8,823 lbs. The garbage was then subjected to the reduction process and it was found from the results and analyses that the total amount of grease was about 4.71 per cent. of the weight of garbage. It is impracticable to recover all of the grease, but it is stated that by the use of the naphtha process the total amount of grease which could have been recovered would have been about 4 per cent. of the weight of the garbage.

COST ANALYSIS FOR CONTRACTORS.

The American Society of Engineering Contractors has for some months been working upon a uniform system of cost analysis for contractors, a committee having been appointed and discussions having been held at the monthly meetings of the society in New York and by some of the sections of the society in other cities. The subject has been freely discussed at these meetings by many contractors and a certain amount of progress is apparently being made. At a meeting in New York Edmund A. Pratt, under the title "A Simple Form of Cost Analysis," presented a form dealing with reinforcement in concrete work. This was somewhat modified by the discussion which followed, the resulting form being that shown herewith. The form presented is not intended to be kept in the field, but in the office, containing the results and total of records kept in the field. It seemed to be the general idea that the most convenient size for the form was that of the ordinary letter head, as it made it convenient for filing and for reference. As indicating the general ideas of the members concerning the subject of cost analysis we quote certain remarks from the minutes of that meeting as published in the September number of the Journal of the society:

Secretary Wemlinger—Although we have become acquainted with many and various systems and forms for cost keeping and cost analyses, few of such are sufficiently simple and convenient to become available for general use. It is our aim, therefore, to determine what features, classifications, items or subdivisions are desirable or necessary in cost analysis blanks, so that the engineering contractor who needs to study his costs can readily do so by using some of the standard forms and methods recommended and adopted by the society.

Mr. Lockwood—Concerning cost-keeping systems there is always danger of too much detail. In a certain shop a very elaborate system was put in to revolutionize the work and to show how much the owners were losing. At the end of the year they had lost $30,000; the system was so complicated with minute detail that it took half the time of the men to fill out cards.

Mr. Smith—There is a weekly time card that I saw one contractor use, something like that illustrated below:

Foreman, F. C. Burke.

Laborer, John Angelo.

Day.	7	8	9	10	11	1	2	3	4
Monday	A		C		D	C		A	
Tuesday	B								
Wednesday	D	E		A		D			C
Thursday	C								
Friday	E					D			
Saturday	B	A		B			E		C

At the top of the card is written the foreman's name and the name of the laborer. The first column is for the day, there being six spaces, one for each day of the week. Across the top, under the names, are printed the working hours. In the morning the foreman would take the card for each man and write a capital letter to indicate the class of work that the man was working on; later, say nine o'clock, if he changed him to another class of work, he would write another letter in the column 9. Every time the workmen were put to work on some other part of the job the proper classification letter was entered in the time column. . . . The foreman took the cards from the men every morning at seven o'clock and kept them in his pocket until noon, when he handed them back to the men. Then at one o'clock he took the cards back and entered the proper classification of work for each man. At five o'clock the cards were handed back to the men, and the whole thing repeated each day.

Mr. Wake—We find that the finer we try to get the records the more inaccurate they are. If you give the contractor too much to keep track of he cannot, or will not, do it.

Mr. Wemlinger—The object of cost keeping is not like that of book-keeping, to itemize everything to cents, but to get an approximate idea of the various costs. That is what we aim to do.

Mr. Wake—A contractor could not afford to keep these records if we go into too much detail.

Mr. Wemlinger—The large organization can afford to keep them, but we want to devise blank forms for the fellow that cannot afford to keep a man busy keeping track of all these details. We want something for the contractor who may have to do all this work himself.

Mr. Watson—The efficiency of any system of cost analysis depends, in the first place, on the accuracy of cost records. To serve the purpose well these must be clear and reliable and the conditions of the work concisely explained. Furthermore, the items of cost should be kept in accordance with some uniform system, so that records of different jobs may be compared intelligently and used advantageously in the analysis of costs for future estimates.

To get costs and to make the proper distribution on the records should be the duty of one man alone. If this man is shown what to do and how to do it, where and what changes to make, and is on the job all the time, keeping a journal and photographs as well, then at the end of a job these records are worth something; but ordinarily the timekeeper simply makes the easiest distribution he can and gives no details.

By watching the reports I myself know what job needs my attention most and when. Some contractors say: "The job is not large enough to pay the costs of a clerk." This is the biggest mistake possible, for every job will pay a clerk's wages. If you are losing money have him more than ever, for the records will show what the loss is and the reason why, and you can avoid making the same mistake again. My experience is that foremen and assistant superintendents who keep good cost records are not fit for anything else, as a rule, and could not get the work done for the estimated cost. For that reason, I say emphatically, have a cost clerk on every job; the better the man the more money you will make in the end.

In a discussion by the Indianapolis section of the report of the Committee on Uniform System of Cost Analysis considerable time was devoted to discussing the possibility of utilizing the facts obtained by such analysis in preventing the recognized evil of the low bids submitted by inexperienced contractors, which bids are too often accepted to the injury of both the contractor and the city or other party for whom the work is done.

The distinction between productive and non-productive labor and material was made a point of discussion also. In connection with the discussion DeWitt D. Moore, chairman of the committee, called attention to the committee's chart wherein it was endeavored to classify the several items of cost in a general way, this having formed a part of the report of the committee at the first meeting in 1911.

Mr. C. Brown said:

As a result of the speaker's experience in keeping final records of costs of additions to existing plants, such as sew-

FRONT OF FORM

REINFORCEMENT

COST—ANALYSIS.

Date.....19

JOB .....LOCATION .....

Period.....19 to.....19

Item.	Rate	No. days or quantity	Total amount	Class of u it	Unit cost	% total
Cutting and Bending—						
Foreman						
Labor						
.....						
.....						
.....						
				Lb.		
Placing—						
Foreman						
Labor						
.....						
.....						
.....						
				Lb.		
Materials—						
Steel, f.o.b.						
" Freight						
" Unload'g & cart'g						
				Lb.		
Wire				Lb.		
Total Materials						
Tools*				Lb.		
Repairs*				Lb.		
Grand total				Lb.		100.0

*The total cost of Tools and Repairs for the entire job is to be entered in the third column and is distributed on the total weight of the reinforcement placed, so that the cost of these items is given per pound of reinforcement in the fifth column.

BACK OF FORM

REINFORCEMENT—2

COST—ANALYSIS.

STYLE OF REINFORCEMENT				REMARKS
State whether wire mesh, expanded metal or bars, deformed or plain	No. of mesh, or sizes of bars.	Area of mesh or lengths of bars.	Weight, lbs.	Give reasons for using style of reinforcem't sel.
•				
	Total weight.*		.....	

*This total must be the same amount as the total weight of Reinforcement given in the fourth column on the other side of this sheet..

CONDITIONS UNDER WHICH THE WORK WAS DONE.

Class of Labor; Experienced?.....Inexperienced?.....
Are the workmen members of a Labor Union?..What Union?..
Nationality of Labor? .....
Climate.....Weather: Give percentage of wet days.....
Was any work done on rainy days?.....How many days?....
Was the Reinforcement handled by labor or with derrick or other machine? .....
Describe in detail how handled.....
.....
How was the cutting or handling done? By machine or by hand?.....
Where was the Reinforcement placed? If in an excavation, what was the size and depth of this excavation?.....If in a building, how many stories?.....If in a bridge, give length of span.....
.....
If cost of Cutting and Bending or of Placing is high or low, give reasons why.....
Suggestions that will improve the conditions under which the work may be done again, and that will reduce the cost if this was high .....

ers, waterworks, and the like, in which distinctions must be between new construction and maintenance and repairs, he strongly urges the separation of items on the basis of productive and non-productive labor and material. The separation is made quite generally in the schedules offered in the committee report and in Mr. Luten's discussion of the same, but incidentally rather than upon a fixed principle. It may, therefore, help to point out this principle in order that it may serve as a guide to determine the method of handling the details.

The distinctions between the above two classes of labor and material are as follows:—

1. What might be termed productive material and labor, to borrow the term without modifying it to fit the facts exactly, is material that remains in the work and forms a permanent part of it, and labor which puts that material in its place and keeps it there.

2. Non-productive material and labor figuratively speaking, consists of tools, equipment, etc., used in handling the material put into the work and in holding it in place temporarily; such non-productive material being then removed permanently from the work, thenceforth to have no further conection with it. Non-productive labor is the labor which is put upon this non-productive material, in preparing it for use, in disposing of it, transporting it, etc.

3. There is also the usual class of non-productive labor, i.e., labor which has no direct effect in putting the materials into their positions in the structure.

- Cost
  - 1. *Material*
    - 1. Actually entering into work ÷ by items of diff. character.
      - 1. Actual quantities.
      - 2. F. o. b. price.
      - 3. Waste.
    - 2. Accessory or incidental.
      - 1. Quantity.
      - 2. Price.
      - 3. Salvage & loss.
    - 3. Labor ..... 1. Delivery to job.
  - 2. *Labor*
    - 1. Direct or productive....
      - 1. Itemized by sections of varying character.
      - 2. Itemized by kind of work done (Gen. Div.)
      - 3. Spec. divisions, pay work.
    - 2. Indirect or non-productive.*
      - 1. On job
        - 1. Supervision
        - 2. Repairs.
        - 3. Incidentals.
      - 2. Material delivery (A material charge)
      - 3. General supervision.
    - 3. Yards or shop, direct labor.
  - 3. *General Charges.*
    - 1. Direct to job..
      - 1. Bond and insurance.
      - 2. Expense.
      - 3. Fittings and repairs.
      - 4. Fuel and oil.
      - 5. Specials.
      - 6. Commissary (where required).
    - 2. Indirect to job
      - 1. Petty tools.
      - 2. Tools and machinery.
      - 3. Yard and shops, payroll and expense of general character.
      - 4. General office payroll and expense.

Note.—Under General Charges.—To be proportioned over cost of material or labor, or their sum.

*To be proportioned over the various items of productive labor.

CEMENT STRONG ROOMS.

In a recent English test of the burglar-proof qualities of vaults of reinforced concrete, a slab of the material six inches thick was perforated with a hole 3½ inches in diameter by means of the oxyacetylene blowpipe. When a steel bar was reached, it was instantly fused away by directing a jet of pure oxygen on the white-hot metal, but this metal-cutting jet had little effect on the concrete.

The time required for making the hole was 24 minutes. As a similar hole in any kind of steel could be made through an equal thickness within four minutes with the jet, it was evident that the concrete offered an important advantage for strong-room building.

SHALLOW FLOORS FOR RAILWAY BRIDGES.*

By O. F. Dalstrom.

In railway bridges of the through type, designed for crossings where local conditions do not govern the depth of the floor system, that depth is determined by sections that give the greatest economy of material consistent with simplicity of construction and facility of erection.

The Shallow Trough Floor Bridge.—The floor beam usually determines the depth of floor in designs of open floor through bridges, whether truss or plate girder type. The term "depth of floor" will be used throughout this discussion to indicate the distance from base of rail to lowest steel of span. If considerations governing the design of the trusses produce panels of considerable length, the stringers, instead of the floor beams, may determine the depth of floor. A single track truss span of 350 to 400 ft., with trusses 18 ft. 6 in. or 19 ft. centres, may have panels over 30 ft. in length. In such a design the economical depth of the stringer would be about the same as that of the floor beam. In common practice the floor beam would still be made deeper than the stringer to obtain simple details of connection between these members.

But conditions of grade and requirements of clearance below the bridge may make it necessary, in a measure, to disregard economy of material and simplicity of construction and erection to obtain designs that will meet all the requirements in special cases. Difficult conditions of grade under clearance, necessitating extreme shallowness of floor, are frequently encountered in crossings over streets and over other railways; and the type best adapted to any particular crossing must be determined by a careful study of the local conditions.

A crossing over another railway usually requires that the grades be carried above the normal grade of the line, with a through bridge over the railway at the apex of the grades. If the approach grades are long and heavy, the slightest reduction in the depth of the floor of the bridge means an appreciable reduction in the cost of the approaches. And—what may be of greater significance than the reduction of the cost of bridges and approaches—it means the reduction of grades that would be costly and otherwise objectionable, or practically impossible, from the standpoint of operation, where local conditions determine the limit of running out of the grade.

The files of the bridge department of the C. & N. W. contain the plans of a large number of bridges that have been designed to meet extreme conditions of clearance grade and curvature. A few of these designs have been selected, with special reference to shallowness of floor, as typical. Fig. 1 shows the floor details in the design of a double track through truss bridge of 170 ft. span, in which the depth of floor is 1 ft. 11 in. This bridge is designed for Cooper's Class E-50 locomotive; or a concentration of 60,000 lb. on each of two axles spaced 6 ft. 0 in. centre to centre.

The floor is of trough construction, the troughs being placed perpendicular to the axis of the bridge. Each trough carries a tie under each track, as shown in transverse section through troughs and floor beams in Fig. 1; the tie is supported at four points on horizontal angles riveted to the tops of diaphragms extending between the webs of the troughs. In every alternate trough, except those adjacent to the floor beam, special diaphragms are provided near the ends of the ties. To these diaphragms the ties are anchored by bolts

*A paper before the Western Society of Engineers, December 13th, 1911.

through the horizontal angles at the tops of the diaphragms, which are so located in the troughs that the bolts will be about 4 in.—a convenient working distance—inside the guard rail. The horizontal legs of the angles at the tops are turned toward the ends of the ties to make the bolts accessible after the ties are put in place. The tie bolt diaphragms are omitted in the troughs adjacent to the floor beams, as they would interfere with the driving of the field rivets at the ends of these troughs.

The troughs (half-section, B-B), are carried by longitudinal girders which are parallel to the trusses, and placed at a sufficient distance from the lower chord to permit ready inspection of the chord and girder. The longitudinal girders are carried by the floor beams (half-section A-A), which are designed to receive the entire panel load and transmit it to the truss.

The troughs are designed to carry a concentration of 60,000 lb. on each track, each concentration distributed over two ties. This gives a load of 30,000 lb. on each of the two ties carried by the trough, or 60,000 lb. carried by the trough. The floor beam is designed to carry the load from the intermediate troughs, concentrated at the bearings of the longitudinal girders, 2 ft. 1 in. from the centre lines of the trusses; and, in addition, to carry its part of the load on the ties in the adjacent troughs.

The heavy load carried by the floor beam, together with its greater length, requires in this member a section considerably heavier than that of the troughs. The depth back to back of angles is made the same in the floor beam and troughs, but the addition of flange material required to give the necessary section modulus in the floor beam, makes the extreme depth of this member somewhat greater than that of the trough sections. This extreme depth of floor beam determines the depth of floor for this type of bridge. By flattening the rivets under the rail and allowing a clearance of 1 in. from the base of rail to the tops of the flattened rivet heads, a satisfactory section is worked out with a depth of floor of 1 ft. 11 in.

It will be noticed that the material in the floor beam and trough sections is not disposed symmetrically with reference to a horizontal line at the middle of the section. In order to obtain the most effective distribution of material, the neutral axis is maintained at the middle of the section. The metal is increased on the tension or lower side to make up for the reduction of section by rivet holes, no allowance for reduction of section by rivet holes being necessary on the compression or upper side of the section.

The depth of the longitudinal girders is made considerably greater than economic considerations require for the section. This is done to obtain a good detail at the end bearing and at the connection to the floor beam.

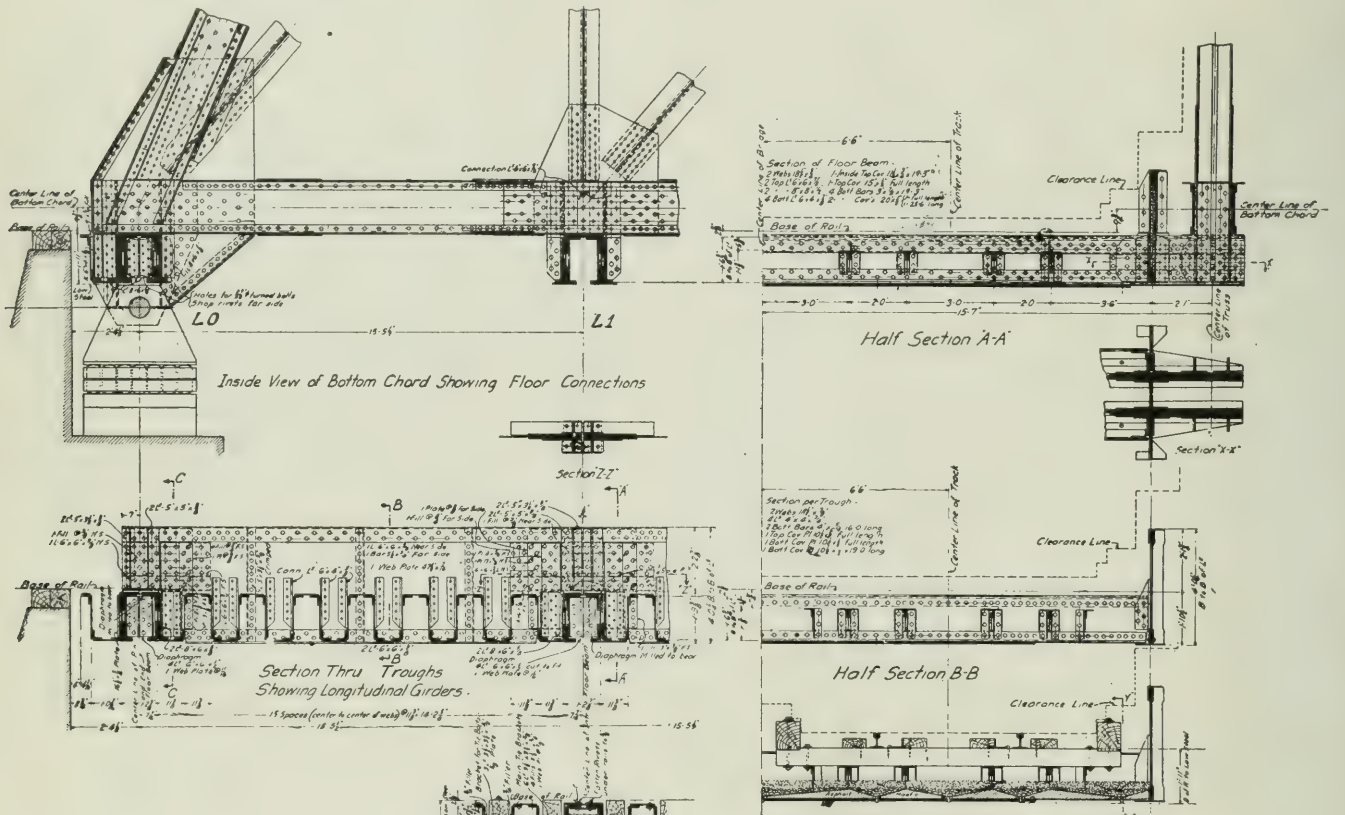
Inside View of Bottom Chord Showing Floor Connections
Section Thru Troughs Showing Longitudinal Girders.
Transverse Section Thru Troughs and Floor Beam Near Center Line of Bridge
Half Section A-A
Half Section B-B
Typical Section Showing Floor and Drainage
Clearance Line
Base of Rail
Center Line of Bottom Chord

Fig. 1.—General Details of Shallow Trough Bridge Floor.

The top flange of this girder is unsymmetrical, being composed of a plate and an angle, the angle placed with its face against the web, the horizontal leg projecting over the top of the web and outward from the track. This detail of the top flange is to gain an additional horizontal clearance, as at this point the structure approaches nearer to the clearance diagram than at any other place except at the end post, where the edge of the cover plate is coincident with the extreme vertical line of the clearance diagram. An advantage in erection is also obtained by this detail of top flange section, as it permits setting the trough sections in place on the bottom flanges of the girders, with only a very slight displacement of the girders from their permanent position.

To further facilitate erection of the troughs, the stiffeners are omitted from the inner side of the longitudinal girder. The end connection angles of the troughs, which are field riveted to the web of the girders, are placed high enough so that the tie bolt diaphragms near the ends of the troughs will not interfere with the driving of the field rivets at the ends of the troughs in which the tie bolt diaphragms occur.

The troughs are drained through 1 in. gas pipes fitted into holes in their bottoms and projecting slightly below the trough to form a drip. This projection of the drain pipes must not extend below the line of low steel determined by the rivet heads on the under side of the extreme cover plate of the bottom of the floor beam. The upper ends of the drain pipes are threaded into washers to hold them in place. The lower part of the troughs is filled with asphalt mastic, the surface sloping toward the drain pipes and flashed over the washers at the upper ends of the pipes. A layer of broken stone covered with gravel is spread over the mastic for a protection.

sections. There is no interference from the girder in driving the rivets on the outside of the truss, but these rivets, up to the level of the tops of the girders, should be driven at the same time that the riveting on the opposite side of the truss is done.

In the development of this type of shallow floor for double track bridges, the first efforts were directed toward obtaining an open floor design, with stringers beneath the track, transmitting the load directly to the floor beam. The excessive bending moment in the floor beam, resulting from this arrangement, made it impracticable to design a floor beam that would come within the required limits of depth of floor.

Following this, a trough floor type was designed, differing from the one shown on Fig. 1 in that it had no longitudinal girders to carry the troughs. Instead, the troughs were extended to the trusses and connected to the bottom chord in the same manner that the floor beam in Fig. 1 is connected to the chord at the panel point. The bottom chord was designed to act as a girder, to carry the panel loads to

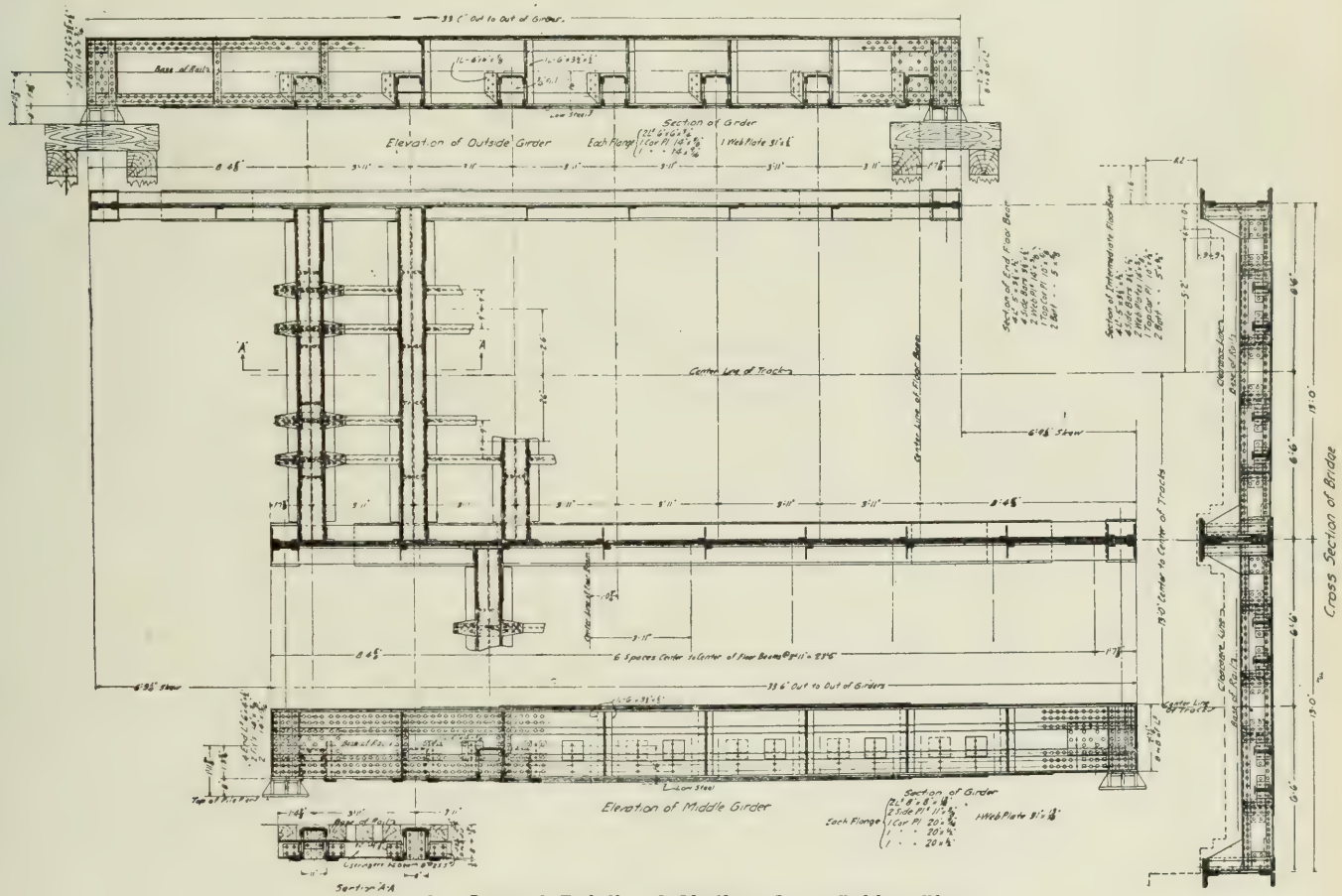
Elevation of Outside Girder
Section of Girder
Elevation of Middle Girder
Cross Section of Bridge
Centre Line of Track
33'6" Out to Out of Girders

Fig. 2.—General Details of Shallow Open Bridge Floor.

The deflection of this floor under a maximum load is considerably greater than that of floors designed for depths determined by economical sections. Under maximum load the theoretical deflection at the centre of the floor beam is 0.65 in. The erection of truss bridges of the open trough floor type requires a special order of work in riveting, owing to the longitudinal girders being located so close to the trusses. After the girders have been placed in position, no riveting can be done on the inside of the lower chord opposite the girder. On this account all riveting in the trusses below the level of the tops of the girders must be done before the girders go into place, which means that all lower chord splices, floor beam connections to trusses, and web member connections to gusset plates, up to the level of the tops of the girders, must be riveted before placing girders and trough

the panel points. This design brought the depth of floo within the required limits, but made the troughs excessively heavy. The bottom chord was necessarily made deep and heavy, since it had to act as a beam for the floor troughs at the same time that it was doing duty as a tension member in the truss.

The next step was the introduction of the longitudinal girder. This was placed as close to the track as the clearance diagram would permit, to reduce as far as possible the bending moment, and thereby the sections, of the floor troughs. The introduction of the longitudinal girder changed the bottom chord from a combined beam and tension member to a simple tension member, and eliminated from it the objectionable secondary stresses produced by the vertical loads applied at the trough connections.

Below are given a few figures for the comparison of a 170 ft. double-track span of the above type, and a double-track span of the same length, with the usual open floor construction, in which the floor beam and stringer sections are determined by the economical depth.

	Shallow trough floor type.	Deep floor type.
Depth of floor	1 ft. 11 in.	4 ft. 9 in.
Weight of floor system per lineal foot of bridge	5,000 lb.	1,700 lb.
Weight of trusses and bracing, per lineal foot of bridge	3,400 lb.	3,250 lb.
Weight of 170-ft. span, complete	1,496,000 lb.	900,000 lb.
Total cost of span, f.o.b. cars at bridge company's plant, at $0.025 per lb.	$37,400.00	$22,500.00

Difference, $14,900.00 = 66.2 per cent. of deep floor type.

As the depth of floor is increased, the weight diminishes rapidly. At 2 ft. 4¼ in. depth, the weight is 4,100-lb. per lineal foot of bridge. Further increase of depth would show a corresponding decrease in weight until the minimum thickness of material in sections is reached.

Unit prices in bids submitted by bridge companies for the fabrication of material for the shallow trough floor type have been found to run about the same as those submitted at the same time for open floor truss bridges. On this basis, a comparison of the two types of the span selected shows that the shallow floor type would cost, f.o.b. cars at bridge company's plant, about 66 per cent. more than the deep floor type. The cost per ton for erecting would be about the same for both types. The number of field rivets per ton is somewhat less in the shallow floor type than in the other type; but an allowance, for which no figures are at present available, must be made for the order of procedure in riveting, which requires that part of the riveting be done before all the material in the bridge is assembled, and for the additional falsework and blocking that are necessary under the floor system to provide for the uninterrupted movement of the trains.

The comparison of costs of the two types erected would show about the same relation as that of the costs of fabrication.

The range of application of floors of this type in double-track truss bridges would cover depths of floor of about 3 ft. and under, if the panel lengths do not exceed 15 ft. With a depth of floor over 3 ft. an open floor bridge is practicable and would be more economical.

For double-track through girder bridges, where panel lengths can be varied as desired, the application would be limited to about 2 ft. 6 in. depth of floor.

The Shallow Open Floor Bridge.—A design of open floor, double-track bridge, with 1 ft. 6 in. depth of floor is shown in Fig. 2. This is the plan of a bridge erected near Mapleton, Wis., on the new line of the M. S. & N. W. The design shown is for a double-track bridge, but the type is applicable to crossings with any number of tracks at the standard distance of 13 ft. centres. The limitation of this type of bridge is in the direction of span lengths, being suitable only for spans of less than 40 ft.

The relation of the clearance diagram to the girders shows that in the longer spans the girders and not the floor beams or stringers determine the depth of floor. The section of the middle girder, which carries load from both tracks, is exceptionally heavy, while that of the floor beams have no shapes over ⅝ in. thick. In shorter spans, 20 to 25 ft., it would be possible to make a shallower girder and reduce the depth of the floor beam so that the depth of the floor would be about 1 ft. 3 in. At that depth the stringer would be so shallow that any further attempt to reduce the depth of floor would result in stringers so shallow and short, and floor beams so close together, that the floor would consist of floor beams connected by diaphragms acting as stringers. It would be approximating the type described above under the name of shallow trough floor bridges.

In spans of 15 ft. or less, the girders can be brought under the third offset of the clearance diagram, making the floor beams shorter and lighter. At this point the depth of floor would probably be determined by the stringer, and the floor beam would be designed in accordance with that depth.

The Rail Girder.—Fig. 3 is the plan of a girder designed to carry a track over a 4 ft. 6 in. clear span in places where there is not sufficient space for stringers and ties below the rail. Conditions requiring such designs are not uncommon in railway yards and in city streets, where pipes and conduits are laid close to the grade of the track.

This design consists essentially of an independent girder for each rail, built up of Z shapes and bars. Section E-E is a transverse section of the girder, showing the rail held in place by cast iron clips bolted to the webs of the Z's. The depth of floor is 3 in., using the term in the same sense as in the discussion of the previous tvpes.

In the design of the girder it is assumed that both rail and girder will be effective in resisting the bending under load. They will act as separate units, however. Both rail

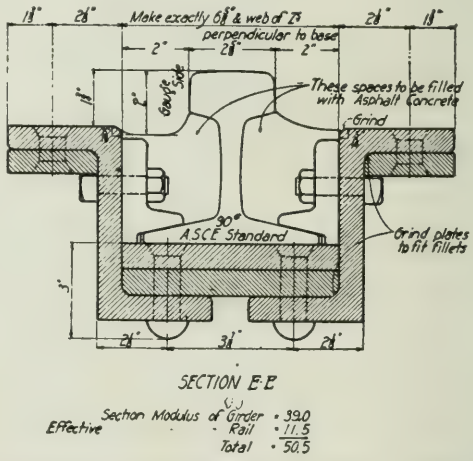
Make exactly 60° & web of Z perpendicular to base
These spaces to be filled with Asphalt Concrete
Grind
Grind plates to fit fillets
30# A.S.C.E. Standard
SECTION E-E
Effective Section Modulus of (a) Girder .390
Rail .11.5
Total .50.5

Fig. 3.—Details of Rail Girder for Shallow Bridge Floors.

and girder will be deflected the some amount, but as they are of different sections, the stresses in the extreme fibres will not be the same, but will be proportionate to the distance of the extreme fibre from the neutral axis in each case. This distance in the girder is 3 in. In the rail shown it is 2⅞ in., or 0.96 of that of the girder.

The section modulus of the girder given below, Section E-E, is the actual section modulus of the net section of the girder. The "effective" section modulus given for the rail is 0.96 of the actual section modulus of the rail. The sum is the effective section modulus of girder and rail acting as separate units, and deflected the same amount.

Section E-E shows a 90-lb. A. S. C. E. rail section, on the girder. Any type of rail can be used with the girder by varying the details of the cast iron clips to conform to the section of the rail to be used. The space in the girder on each side of the rail is filled with asphalt mastic, to protect the steel and provide a run off for drainage.

The weight of a pair of girders of the section shown in section E-E is about 1,500 lb. The weight of a pair of the special section is practically the same as that of the standard section.

CONCRETE CONSTRUCTION.*

By E. Brown, Professor of Applied Mechanics and Hydraulics at McGill University.

Concrete construction has many followers, ranging from the rabid enthusiast who will assert that it is the thing for almost every kind of building, to the more modest and perhaps more effective advocate who realizes at one and the same time its advantages and its limitations. There was a day when it had its opponents, but its record of actual achievement in the past few years has established its claim to being one of the principal forms of construction at the present day. The opponents have become friendly critics or even converts, and I imagine there are now very few who are so blind as to ignore the facts of the situation. There are, however, some who seem to think that a designer in reinforced concrete is drawing on his imagination (shall I say) to a much greater extent than a designer of steel work. Some steel designers, at all events until recently, would almost give you the impression that their work was calculated to such a nicety as compared with that possible in reinforced concrete work, that the latter by comparison had very little claim to exactitude. I am not here advocating one form of construction as against another, nor any particular type of either form, but I do say that if we set down the exact conditions of the problem confronting a designer in these rival forms of construction, there is not much to choose in the matter of exactitude. I am not here concerned with any considerations of actual construction. We can have good and bad work in any kind of construction. I am speaking of the conditions of design. The problem is always this, no matter whether it is a design for a huge bridge or for an office building or store.

(1) To make some estimate, more or less exact, of the forces which will probably be brought to bear on the structure considered. Floor loads, wind loads, etc.

(2) By some theory, more or less exact, to determine the forces which the above estimated loads will produce in the component parts of the structure.

(3) From our knowledge, more or less exact, of the physical characteristics of the materials employed in the various parts of the structure, to so proportion those parts that they may withstand successfully for an indefinite period, the forces which are estimated to come upon them.

After that it is necessary to have the work carried out in strict conformity to the designers by efficient labor, under the best supervision. In the matter of the first two processes above, designers of steel work and of reinforced concrete work are on the same footing.

As regards the third point, our knowledge of the properties of concrete, and of the effects of changes in its composition is now of considerable extent, and I do not think that a conservative designer need have any anxiety in regard to the behavior of his structure if reasonable, sound specifications are lived up to. Steel designers, in recent years, have come to consider much more carefully than heretofore, the probable effects of eccentricity in some of their details, and in this, reinforced concrete designers can learn from them. In the particular case of columns consisting of angle and other sections latticed and tied together, we are only in the early stage of finding out how they really act. I could show you experimentally the actual conditions of stress in such a member as a tie bar made up of two angles, back to back, connected by a plate at their ends, and separated at intervals by distance pieces—one of the commonest forms of construction imaginable. Experiments of a very interesting character are being made by one of our staff at McGill on this matter, and all I need say to emphasize the point I am now making, is that any steel designer who thinks that even such a simple built up member acts as one piece has another "think" coming to him. No, gentlemen, we are all engaged in "estimating" something. Formulae expressing the complex action which is going on in either a steel structure, or in one of reinforced concrete may be forthcoming, but of this I have grave doubt, and even if they are, we shall, for practical purposes, make such modifications of them as will eliminate from them any complexities which are due to effects which are either of small magnitude, or which can be allowed for in a simpler manner.

A survey of the development of our professional work generally will show that whenever and in so far as it has been possible to exalt any branch of that work to the rank of a science, the progress has been due to the gradual but certain development of a few fundamental ideas. Our great electrical industries of to-day have developed by applications of the great principle discovered by Faraday when he found that a closed coil of wire moved across a magnetic field generated an electric current. And while few of our branches of engineering science are as scientifically exact as the one I have just mentioned, in all or most of them there is such a mass of practical experience and of results of tests to couple with some simple fundamental ideas expressing actual conditions but inadequately, that we can go ahead with our designs with complete confidence in the results. The science of hydraulics is an instance of this phase of the work of our profession.

So that while I for one would not be prepared to admit that the steel designer can figure the actualities to a much finer degree of accuracy than the reinforced concrete designer, I do think that the latter depends to a tremendous extent on the honesty and sincerity with which his plans are carried out. Structural mild steel is manufactured in our steel mills under reasonably uniform conditions, and speaking broadly of course, an engineer buys it in the open market with considerable confidence in its physical properties. He knows that he can figure safely on 16,000 pounds per square inch in tension, and that if he is cutting his sections as finely as possible, he may reduce them by say 10 per cent. and increase his unit stress accordingly. The properties of his material are not altered. He is **not** taking an **unknown** risk.

But in concrete construction the material by which the compressive forces in the structure are carried is made and laid on the spot and is liable to such variations in mixing as may occur in practice quite apart from any variations in quality due to change of composition. If we reduce cement by say, 10 per cent., use an inferior sand, or change the nature of the aggregate without definite knowledge of the effects of this change—if we do all or any of these things we are altering to an uncertain extent the physical properties of our concrete. We **are** taking an **unknown** risk, and one which to my mind is entirely different in character from that involved in a cut of a definite per cent. on steel sections. We know from experience that certain expectations in the properties of mild steel will almost certainly be lived up to, and it is in the power of those engaged in reinforced concrete work to produce a concrete equally uniform and reliable. A successful designer has always in mind certain possible differences between assumed and actual conditions, and it is in a proper realization of such differences, and in the capacity of the designer to apreciate the extent of their influence, that reliance must be placed. If for any reason he may fear that the concrete will only stand a compression stress of 400 pounds per square inch, instead of perhaps 600, his oppor-

*Abstract of paper read before Montreal Builders' Exchange.

tunities to make both a successful and economical design are at once limited. Poor concrete is much the same weight per cubic foot as good concrete, and if the concrete is poor, and only capable of safely carrying a small compressive stress, more is required to sustain a given compression load, and hence, more steel is required to carry the extra dead load necessitated. But we **can** get uniformly high grade concrete if proper care is exercised. At the same time the calculation of a designer can be rendered of little avail if the actual work is not carried out in a thoroughly conscientious manner.

Any theory of reinforced beams starts from the assumption that the several layers of the beam are lengthened or shortened by an amount proportional to their distance from the plane separating tension and compression areas. Careful experiment shows while this is not rigidly true in all cases, it is conformed to with reasonable accuracy in most cases. Accepting it as true we shall get different results for the bending moment which the beam can carry according as we assume.

(a) Variable modulus following assigned law.

(b) Modulus uniform during loading.

(c) Different values for uniform modulus.

Assume a rectangular beam 10 inches deep with, say, one per cent. reinforcement. Then, taking average concrete, one should find that under working loads the distance from the steel line to the point in the section where the resulting compression acts is about 8 feet 6 inches if we assume a variable modulus with the definite law of variation; 8 feet 8 inches if we assume a uniform modulus of 3×10^6 pounds per square inch.

The safe bending moment on the beam is the product of the allowable force in the steel and one or other of the above numbers. It is evident that the difference shown in the safe bending moments is only some 2½ per cent., and any attempt to figure to such a degree of supposed accuracy is foolish. Rods, in practice, may easily be displaced by an amount affecting strength of calculations far more than do these different theories.

These figures neglect concrete tension and their differences indicate the extent to which different methods of calculations affect the broad features of design. Under the specifications adopted by the American Society for testing materials, the American Society of Civil Engneers, and the Maintenance of Ways Association, all concrete is now taken to have the same modulus, a great change since the days when cinders, rock concrete, gravel concrete, etc., were all supposed to have a different modulus, and following a different law of variation as the load increased. It has been amply demonstrated that all these were unnecessary refinements and the standard specifications recently drawn up have swept them away. Similar simple specifications were drawn up earlier by the Royal Institutes of British Architects, and I would urge the adoption of some such standards here. I do not believe you have any such standards at present. When in Toronto a couple of years ago attending the Cement Association Congress I learned that their buliding by-laws prohibited a designer from figuring any continuity in reinforced concrete floor systems, and I believe that foolish and unjustifiable prohibition still stands. It seems to me to eliminate competition to a great extent and to leave a clear field for the steel construction. Here, in Montreal, I do not think you are hampered by any by-laws on such matters—it is more of a go-as-you-please. You are more familiar than I can be with the results of this, but unless something miraculous happens, the usual result of such conditions is to find one design called for according to one set of specifications, another design according to another set, and so on. Now, even if all these varied specifications are beyond reasonable criticism—which is questionable—would it not be better to have a working standard? Our railroad bridges and highway bridges are built under standard specifications, and it seems to me desirable that there should be some standards in this matter also. I am sure it would be advantageous to have something of the kind, whether the architect prepares the plans in his own office or has them prepared independently by an outside firm.

PATENTS AND THE ENGINEER.

The following is the outline of an address delivered to the Engineers' Club, of Toronto, on Thursday, January 11th, by Mr. J. E. Maybee, patents solicitor of Toronto.

The main purpose of the address was to point out to prospective inventors the proper course to follow if they wished to avoid the more common pitfalls which beset the inventor's path. The great inventions, outside a few lucky hits, are not made by men who sit down with the idea of inventing something but in response to the stimulus of a known want.

An inventor who succeeds with the least waste effort will follow fairly closely the following order of procedure, which is given substantially in the lecturer's own words:

1. Find a want, i.e., be sure you have a market. It pays to devote the utmost care to gauging the needs of your public.

2. Be sure you have, or can acquire, a sufficient quantum of knowledge to enable you to direct your efforts wisely.

3. Obtain as wide a knowledge as possible of the inventions of others along similar lines. (Some in practice do this just before taking step No. 6.)

4. With sweat of brain evolve a new idea and embody it in concrete form.

5. Devote every effort to **work out your details** as thoroughly as possible, so that your device will not only work well, but what is just as important, **can be easily and cheaply made.**

One of the most fruitful fields for inventors lies in devising means for more cheaply making various articles of manufacture or in devising simplified forms of commonly used articles or machines.

6. See that you get as good a patent as can be obtained.

In both patents and inventions "pretty near is not good enough." In a recent address before the Engineers' Club, of this city, Mr. Justice Riddell pointed out that failure to keep the above maxim in mind led to such disasters as the Austin dam failure, and unless the inventor would court failure he must make "as good as possible" his motto, and he should select professional advisers who will live up to the same rule.

It was pointed out that engineers, as a rule, did not figure largely as patentees, the exceptions being those specially employed by large concerns to perfect their goods or machinery.

The main reason given for the lack of inventiveness of the engineer was the necessary conservatism of his procedure in his work, whereas the disposition of the typical inventor was to exhibit a contempt for authority and tradition.

A strong plea was made to the engineering student to acquire as broad a general culture as possible and to cultivate the imaginative faculty which in essence is the same in the artist as in the engineer, and which is one of the most useful and prominent characteristics of a successful inventor.

THE DESIGN OF TALL CHIMNEYS.*

By Henry Adams.

Architects, in the course of their practice, have frequently to furnish designs for special constructions, and although they sometimes adopt the sensible course of calling to their aid the services of an expert, they more frequently draw out what they think ought to do, and place the responsibility upon the contractor. The present condition of general knowledge upon the subject of the stability of tall chimneys is strikingly shown in connection with the Mechernich shaft.† This was designed to withstand a wind pressure of 160 lb. per square foot; Prof. Rankine calculated that it would stand only 70 lb. per square foot, while Mr. R. J. Hutton, a later writer, estimated that a wind pressure of only 32 lb. per square foot over the whole height would be sufficient to damage it. Tall chimneys ought to be designed upon scientific principles, so that there is an absolute guarantee for their stability, and in the following paper the author desires to elucidate these principles.

Height.—In designing a tall chimney‡ it is desirable first to know what height to make it. Forty-five feet is an ordinary height to serve two steam boilers, but in some

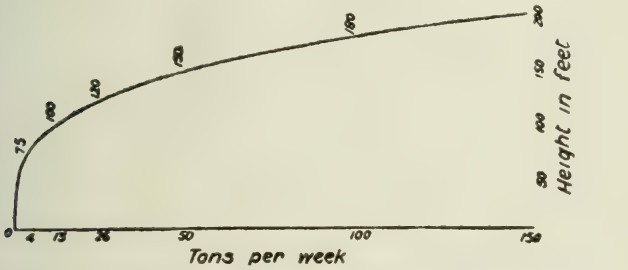

Fig. 1—Height of Chimney According to Consumption of Coal.

towns, as Manchester and Leeds, 90 ft. is the minimum allowed. They are sometimes proportioned for height according to the coal burnt per week of fifty-six hours, thus:—

4	tons	per week	=	75 ft. high.
13	"	"	=	100 "
26	"	"	=	120 "
50	"	"	=	150 "
100	"	"	=	180 "
150	"	"	=	200 "

This table is checked by the graphic curve shown in Fig. 1. Another rule is to make the height of the chimney three times length of boiler + twice distance of furthest boiler to chimney. This allows 1 ft. of height for every foot the gases travel round the boiler and 2 ft. of height for every foot of external flue. And again, a round chimney should not exceed twenty-five times its internal diameter in height. In many modern power stations Babcock & Wilcox boilers and Green's economizers are used; what is saved in obstruction in the boilers is lost in the economizers, so that no material difference arises, but the chimney shafts are, as a rule, only from 75 ft. to 100 ft. high, and of very large sectional area. For chemical works, or where poisonous fumes are emitted, they should be higher than for ordinary steam boilers, in order to disperse the fumes at such a height that they may be diluted to a harmless condition by the time they reach the ground. The Townsend chemical works chimney at Glasgow is 454 ft. high, and was, when built, the highest in the world.

Sectional Area.—The sectional area or internal diameter is the next point to decide, and there are many different rules, some depending only upon the coal consumption, others upon the firegrate area, and others upon the water evaporated in a given time. Simple approximate rules are:

(a) 1 sq. ft. area for each cwt. of coal burned per hour.

(b) Area = one-tenth of the total firegrate area, each flue being one-fifth of its firegrate area, and main flue one-eighth of total.

(c) 2½ sq. in. per indicated horse-power of the engine.

(d) If the height of the chimney is taken into account, as of course it should be, then on the average—

$$\text{area} = \frac{\text{lb. of coal burnt per hour}}{12\sqrt{\text{height in feet}}}, \text{ or } \frac{\text{fire-grate area sq. ft.}}{1.5\sqrt{\text{height in feet.}}}$$

Shape.—The necessary sectional area being obtained, it should next be decided whether the chimney is to be round, octagonal, or square. It is generally acknowledged that circular chimneys have the best appearance, at least above the pedestal, which is usually square, and from which the circular part springs by broached angles. Octagonal chimneys have the next best effect, some even consider that they are more sightly than round chimneys, while square chimneys always look more or less heavy, and are only suitable for short stacks of large area, such as are generally used in modern central station work. The circular chimney is most efficient for its area, as it takes the least material and there are no angles in which soot may cling; but with any chimney it is desirable to add 2 in. all round to the calculated minimum area to allow for friction. Octagonal chimneys require special bricks for the angles in alternate courses, to produce the best work.

Wind Pressure.—The comparative efficiency according to the shape of cross-section may also be considered from the point of view of obstruction to the wind, that which offers the greatest obstruction requiring the greatest stability or quantity of material apart from other considerations. It is not yet definitely settled what is the pressure of the wind upon a plane surface due to a given velocity, and still less

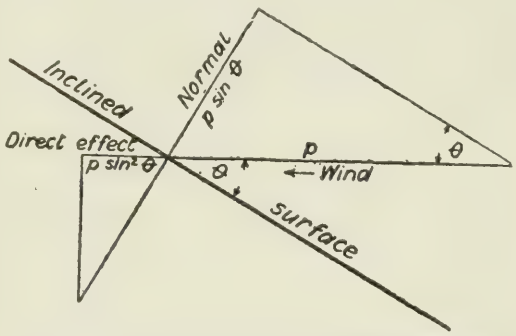

Fig. 2.—Effect of Wind on Inclined Surface.

is known of the effect upon a surface inclined to its direction. We shall generally be quite safe, however, if we allow for ordinary purposes a pressure of 56 lb. (or ½ cwt.) per square foot on a plane surface normal to the direction of the wind, and even half of this may be sufficient in many cases. When we come to fix the value of these figures against an inclined or curved surface we find much difference of opinion and no sufficient experimental evidence.

* Paper read at a meeting of the Society of Engineers, England.

† Trans. Soc. Eng., 1887. Paper by R. J. Hutton on "The Stability of Chimney Shafts."

‡ In different districts this would be known as a high chimney, mill chimney, chimney shaft, chimney stack, chimney stalk, smoke stack, furnace shaft, boiler shaft, etc.

A formula agreeing closely with Hutton's experiments* is:—

$$P = ap(\sin\theta)\ 1.84\cos\theta$$

where P = total pressure in lb.
a = area of surface in square feet.
p = normal pressure lb per square foot.
θ = angle of incidence.

and this is the basis of the majority of tables of effective pressures; but Hutton experimented on a surface only 22 sq. in. area, which was too small to be of much practical value.

Some years ago† the author suggested a variable allowance according to the width and height of the structure, would cover all cases and be more in accordance with modern experiments. His empirical formula for this purpose is now:

$$\log p = 1.125 + 0.32 \log h - 0.12 \log w$$

where p = ultimate wind pressure in lb. per square foot necessary to be allowed for against a plane surface normal to the wind,
h = height in feet of centre of gravity of surface considered, above ground level,
w = width in feet of part to be taken as one surface,

and when the surface is inclined at θ degrees to the direction of the wind, the ultimate pressure normal to the surface may be taken as $= p \sin\theta$, or its effect in the same direction as the wind $= p \sin^2\theta$ (see Fig. 2).

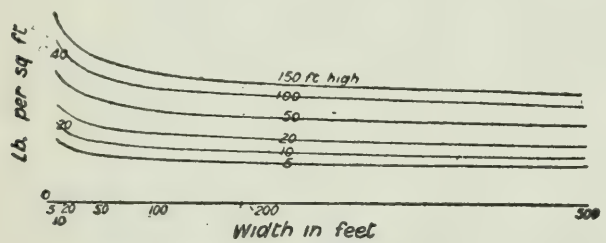

Fig. 3.—Wind Pressure According to Width and Height.

This would give allowances as in the following table, for which the curves are plotted in Figs. 3 and 4.

Wind Pressure Lb. Per Square Foot on Plane Surface.

(For very exposed positions 25 per cent. may be added.)

Height	Width in feet.						
in feet.	5	10	20	50	100	200	500
150	54.6	50.3	46.3	41.4	38.1	35.1	31.4
100	48.0	44.2	40.7	36.4	33.5	30.8	27.6
50	38.4	35.4	32.5	29.1	26.8	24.7	22.1
20	28.7	26.4	24.3	21.7	20.0	18.4	16.5
10	23.0	21.1	19.5	17.4	16.0	14.8	13.2
5	18.4	17.0	15.6	13.9	12.8	11.8	10.6

Multipliers for Angle.

θ	10	20	30	40	50	60	70	80	90
Sin	.174	.342	.500	.643	.766	.866	.940	.985	1
$\sin^2$	.0303	.117	.250	.431	.587	.750	.884	.970	1

In the case of a boundary wall the length to consider would be a portion equal to, say, one and a-half times the height, or the width between the buttresses. In the case of a roof the distance from centre to centre of the trusses should be taken, unless the stability of the whole structure be under consideration, when the full length should be taken. In the case of a lattice girder bridge 50 per cent. should be added to the actual area offered to the wind and both girders taken.

* See paper by the author on "Wind Pressure on Roofs," read before the Society of Architects, March 14, 1893.

† See discussion on a paper by R. J. Hutton on "The Stability of Chimney Shafts," Trans. Soc. Eng., 1887.

The lower part of the above table, shown graphically in Fig. 5, gives the multipliers for angle when the surface is not at right angles to the direction of the wind, the sins being used for obtaining the normal pressure on an inclined surface such as a roof, and the $\sin^2$ for the effective pressure in the same direction as the wind on such a surface as a square chimney placed diagonally.

Theoretically, account should be taken of the effect of the batter in determining the wind pressure on a chimney, but this is so slight that it may usually be omitted.

Pressure on Square Chimney.—A square chimney will give the same resistance whether facing the wind or standing diagonally to its direction, the greater area of the inclined surface and the reduced pressure upon it making the same total as the flat side under the full pressure.

Pressure on Circular Chimney.—With circular chimneys a very serious difference of opinion exists as to the effective pressure of the wind, as shown by the following list of multipliers recommended:—

Rankine.	=.5	Prof. Hutton	=.66
Wilson.	=.56	Gaudard.	=.66
Borda.	=.57	Bressé.	=.78
Sir B. Baker.	=.57	Adams.	=.7854

"Molesworth's Pocket-Book" says somewhere (but owing to the very imperfect index the author has been unable to find the statement again) that "the pressure of the wind upon a cylindrical surface has been given at one-half to two-thirds

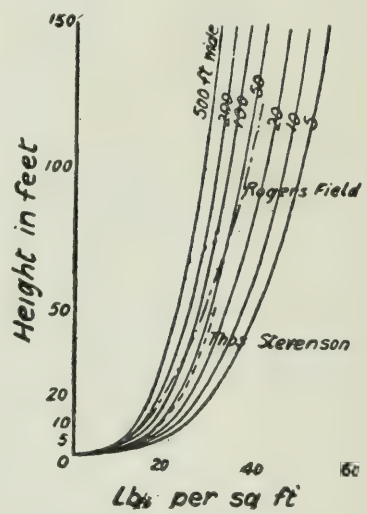

Fig. 4.—Wind Pressure According to Width and Height.

of that against a normal plane, while experiments show it to be nearer three-quarters." C. B. Bender, in a paper on "Wind Pressure," read before the Institution of Civil Engineers in 1882, says "cylinders have the special coefficient of 0.54, but larger surfaces probably increase this value." The author's investigations lead him to adopt $\frac{\pi}{4}$ — as the multiplier, which, if incorrect, is at any rate on the safe side. The area taken for wind pressure in the case of a circular chimney is the diametral vertical plane, and no further allowance need be made for suction on the lee side.

Pressure on Octagonal Chimney.—An octagonal chimney has two extreme positions with regard to the wind—viz., when it is acting directly against one face, and when acting directly against one edge. For the former case the author's multiplier would be 0.83, and for the latter 0.82; there is not much difference, but the latter coefficient gives rather the highest result as it is taken against the width over angles.

(To be Continued.)

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ESTABLISHED 1893.

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THE ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Canadian Society of Civil Engineers is again a matter of history. This year the meeting, which was held in Montreal, was very well attended, and it can be seen from the report, which appeared in the daily issues of The Canadian Engineer and continued in this issue, that a good deal of interest was taken in the discussions.

It looks as if some change were necessary in the present method of carrying on the business of the annual meeting. The time of the meeting is all too short to allow of the discussion of reports of committees, etc. With the present mode of procedure, the first day and the morning of the third day are devoted to business and discussion of reports. The second day is the excursion day to the different plants to be inspected; and the afternoon of the third and last day is reserved for the meeting of the new council.

From the analysis of the discussion it appears that the general consensus of opinion is that the excursion day, or second day, should be devoted to business, and that the discussion of reports of committees be carried on at the meetings of the different branches of the society.

With the elimination of these two matters the business of the annual meeting would undoubtedly be much facilitated, and a great deal more time allowed to the actual affairs of the society.

The excursion is certainly a valuable function, for it aids greatly in the members getting acquainted with each other. However, by postponing it until the fourth day of the meeting it would serve this purpose nearly as well, and would give an additional day to the work of the society. The discussion of the reports of committees, in the opinion of many of the members, could be better carried on at the branch meetings. While there would undoubtedly be difficulties to this method of procedure, still these could be overcome if it were considered advisable to change.

The retiring president, Mr. C. H. Rust, suggested that an annual summer session would be an excellent thing, and the idea met with a great deal of approval. By this means many interesting places and works could be visited by the society as a body, which under present conditions are impossible, and it would afford an excellent opportunity for the members to become acquainted. The latter fact, after all, is one of the most valuable results of the society meetings.

THE LETHBRIDGE SEWAGE SEDIMENTATION TANK.

Patent rights have recently been granted in connection with a sewage sedimentation tank which introduces several novel features of construction. The working principle of the tank appears to be somewhat similar to the type known as the "Emscher," inasmuch as the object aimed at is the automatic immediate separation of sedimented solids into a separate section of the tank. The patented claim, however, only appears to cover the principle of separation or isolation of sludge in connection with rectangular tanks, and the constructive features may not be applicable to circular tanks as with the Emscher design.

Both forms of tank have been fully described and discussed in The Canadian Engineer and elsewhere, and it would appear that the principle involved in these modern types of sedimentation tanks, which is creating much interest in sanitary engineering circles, is likely to supersede the older types of efficiency.

Up to within a recent period we have been accustomed to hear so much about the efficiency of the septic tank that the name has almost become synonymous with the term "sewage disposal." In fact, in many quarters, when a municipality is contemplating the introduction of sewage disposal works, it is common to state that "septic tanks" are proposed without any definite knowledge of the particular form and method of sewage disposal under consideration.

More recently, however, we have been told that septic tanks are a mistake, that they have been founded on error and resulted in failure.

It now appears, however, that there are some good features connected with the much-maligned septic tank, and that it cannot be thrown altogether aside and scrapped. In fact, the newer forms of sedimentation tanks, which appear to meet the demand of modern conclusions and knowledge gained by experiment and practice, are simply a compromise between the old continuous-flow sedimentation tank and the septic tank. With the continuous-flow sedimentation tank the working principle depends upon reduced velocity of flow for the precipitation of the suspended solid matter and the immediate removal of the settled solids to sludge beds adjoining the tank, where they are generally allowed to rot and form the chief nuisance connected with any sewage disposal works. On the other hand, the principle of the septic tank is to allow the settled solids to remain in the sedimentation tank and undergo the rotting process, after which they can, at extended intervals, say, once or twice a year, be removed to sludge beds adjoining the tank without the same risk of nuisance, as the putrefactive process has taken place in the tanks, and the removed solids are practically of a mineral and non-offensive character.

The latter method gained much favor, and, under the term septic treatment, was very generally adopted as more economical and efficient than the daily removal of fresh sludge from tanks.

The method, however, very soon proved itself a partial failure as it was found very detrimental to the final treatment of the tank effluent to allow this sludge or settled solids to remain in the tanks in contact with the continuous flowing sewage.

The newer form of tank meets the above objectionable feature by providing a separate compartment, into which the solids are precipitated, where they undergo septic action or the putrefactive changes necessary to render them inoffensive on removal. At the same time the tank effluent is unaffected by the presence of accumulated putrefying solids.

Thus the efficiency which is peculiar to septic treatment of sewage is attained, together with the efficiency peculiar to the ordinary continuous-flow sedimentation tank. The Lethbridge tank also introduces several novel features, such as the use of wire reinforced glass for the tank slopes so as to accelerate the discharge of the settled solids into the separate decomposing chamber.

The Emscher tank is a German design, while the Lethbridge is Canadian, its name being taken from the city where it is being installed. We understand that this form of tank has been adopted at several other places in Canada.

EDITORIAL COMMENT.

The forestry question in Canada has become an exceedingly important one, and it is one which is of great interest to engineers, closely associated as they are with the building and constructional fields. Our forests have been depleted by fires and by the necessities of life until little remains of our original magnificent heritage. We must look to the future, and in doing so our only salvation is in scientific forestry. The Canadian Forestry Association are doing a great deal towards promoting a sane forestry programme, and the association deserves the support of all engineers. This association are holding their annual convention in Ottawa on February 7th and 8th, and the discussions at this meeting should be productive of much which will be of interest.

* * * *

We have drawn attention in The Canadian Engineer before to the fact that the executive of the Ontario Good Roads Association is completing arrangements for a provincial deputation to attend at Ottawa on Thursday, the 8th day of February. This deputation will wait upon Premier Borden and the members of his Cabinet to present their views in reference to federal aid for good roads and how it can best be distributed and applied throughout Canada, and Ontario in particular. An effort was made to bring this deputation together in December, but owing to the early adjournment of the House and other matters, a satisfactory date could not be secured. In response to the notices sent out in November, more than one-half of the county councils of the province expressed their approval of the idea by appointing delegates. A similar notice will go before the city, town and county councils this month, and it is hoped that all will arrange to be represented. A meeting for the organization of the deputation will be held in the council chamber of the city hall, Ottawa, on the morning of the day appointed, commencing at 9 o'clock.

LETTER TO THE EDITOR.

The Editor:

Sir,—I have read with interest the article by Mr. S. B. Code, O.L.S., concerning concrete sidewalks. This is a subject upon which very little is written; perhaps the idea is so simple, and there is not much to give to the engineering profession.

The suggestions put forward by the writer are well founded, but there are a few points which he touched upon in so general a way as to make the article of less value than it otherwise would have been. It would be interesting to know Mr. Code's opinion as to the proper thickness of the surface mixture, concrete body, and the foundation. I understand that some cities are laying cement walks at the present time, and do not provide any gravel or cinder foundation at all, and their walks have been reportd to be satisfactory. This, of course, is a matter which is governed by locality and condition of the foundation with respect to porousity or impermeability.

Another point is the distance between expansion joints, which are places in the neighborhood of 50 feet. It would seem to me that joints braced thus far apart is too much for ordinary severe climatic conditions, unless all the intermediate joints between each slab are perfect.

I would further remark, that as a general rule pitch between the expansion joints squeezes out during the

summer, and is very objectionable when the cold weather comes.

These points are matters which might well and profitably be discussed by members of the profession, and it would be interesting to get the ideas of various municipal engineers on the subject. Yours truly,

A. C. D. BLANCHARD, City Engineer.
Lethbridge, Alta.

THE CANADIAN HIGHWAYS IMPROVEMENT ACT.

The following is the text of the Act to encourage and assist the improvement of highways, which is now before the House of Commons at Ottawa. This is Bill No. 77 of the first session of the twelfth Parliament.

1. This Act may be cited as The Canada Highways Improvement Act.

2. In this Act the word "Minister" means the Minister of Railways and Canals.

3. The Governor-in-Council may, in any year, and upon such terms and subject to such conditions as are prescribed by order-in-council, grant to any province in aid of the improvement of existing highways or the construction of new highways in such province, or for both such purposes, a subsidy not exceeding such sum as may in such year be voted by Parliament for that purpose.

4. Any highway for which aid is granted to a province shall be improved or constructed, as the case may be, according to descriptions, conditions and specifications approved by the Governor-in-Council on the report of the Minister, and specified in each case in an agreement between the Minister and the Government of the province, which agreement the Minister, with the approval of the Governor-in-Council, is hereby empowered to make.

5. Each highway to be constructed or improved shall be defined and described in such agreement, and provision may be made therein for the future maintenance of such highway in good condition according to a specified standard and to the satisfaction of the Governor-in-Council.

6. The Minister, with the approval of the Governor-in-Council, and upon such terms and conditions as are prescribed by order-in-council, may undertake the construction of any new highway or the improvement of any existing highway in any province, and may expend in such improvement or construction the whole or any part of the sums voted by Parliament for such subsidy to that province. Provided, however, that the Minister shall first obtain the necessary authority from the legislature of such province and the consent of the Lieutenant-Governor-in-Council.

LECTURES FOR INSPECTORS.

The department of health of the city of Toronto have entered upon a series of lectures with a view to broadening and extending the usefulness of inspctors and others. The lectures are held once a week at 4.30 p.m., and all health inspectors are required to attend.

Among the subjects discussed are:—Bacteria, Their Nature and Functions; General Sanitary Inspection; Special Sanitary Investigations; Foods, Their Nature, Uses, Value, Adulteration, Preservation and Possible Dangers; General Food Inspection; The Milk Problem; House and Lodging House Inspection; Hygiene and Sanitation in the Home; Disease Carriers and the Value of Medical Inspection in Schools; Isolation Regulations and the Enforcing of Them; The Municipal Control of Tuberculosis; The Work of the Tuberculosis Nurse; Plumbing Inspection; Meat and Slaughter House Inspection; The Social Aspect of the Tuberculosis Problem; The Work of Charitable Societies in Their Relation to the Work of the Health Department.

An examination is held at the close of the series, when the results will materially effect the standing of inspectors and other employees.

REINFORCED CONCRETE—THE COLD WEATHER BUILDING MATERIAL.

In the winter many factory managers and mill agents are confronted with the fact that they must have an increased space to handle a larger factory production. Often this extension is deferred until the spring, as from bitter experience they are aware of the uncertainty of completion of mill constructed buildings due to the slow deliveries of materials and do not consider reinforced concrete either on account of its higher first cost or doubt as to the safety of construction under cold weather conditions. Buildings with steel frames are not considered, as very few factories are built of this design nowadays.

Very often factory managers will incline to mill construction on account of the lower first cost, while in ultimate cost, considering depreciation, insurance, interest, and vibration with its resultant wear on machines, reinforced concrete is cheaper in most every instance. In winter time concrete work will average from 6 to 10 per cent. more than the cost of work done in warm weather, and mill construction will cost from 4 to 8 per cent. more, but the early occupancy of the concrete building more than offsets the extra cost of concreting in winter, while with mill construction there is absolutely no surety of the completion of the building, four to six months being often taken to finish a building that should be put up in three months.

Reinforced concrete work that has been executed in the coldest weather is just as sound as summer work, provided proper precautions are taken. In New England, with its severe winters, for the last eighteen years a contracting firm in Boston, the Aberthaw Construction Company, have successfully carried through three or four jobs each year, under the most adverse weather conditions.

The principal points of winter concrete work consist in heating the sand, stone, and water before putting the same in the mixer. The cement is not heated, as its setting is hastened to too great a degree. Salt is sometimes mixed with the concrete in the proportion of two pounds of salt to each bag of cement. Of course all snow is removed from the forms by a steam jet, and the whole building as it goes up is enclosed floor by floor with canvas until the concrete is set and salamanders burning coke are placed underneath all freshly poured concrete floors and kept there until the concrete is thoroughly set. In this way the interior of the building is kept about 30 degrees above that of the air outside. The tops of the concrete floors which cannot be enclosed with canvas are covered with about 12 inches of hay or straw, the latter being sometimes sprinkled with salt.

On account of the speed and certainty of erection, together with its numberless known advantages, it seems that reinforced concrete construction in winter will become more and more adopted by factory owners, when it is realizd that with experienced contractors the soundness of the structure is just as good as if it had been erected in the summer time.

REPORT OF ANNUAL MEETING OF CANADIAN SOCIETY OF CIVIL ENGINEERS.

(Continued from daily issue of Jan. 26th.)

Friday Morning's Session—January 26th, 1912. PRESIDENT C. H. RUST in the chair.

THE PRESIDENT: If you will come to order, gentlemen, we will proceed with the business. The examiners of student papers have recommended to award the prize in the general section to Mr. Percy E. McDonald, for his paper on "A General Description of the Structural Detail of Buildings." We will now take up the reports of branches.

THE SECRETARY: The only outstanding branch is Vancouver, and I have not received a report from it.

THE PRESIDENT: We will proceed, then, with the discussion on the reports of committees.

THE SECRETARY: Before proceeding, I would like to call attention to the excursion that is provided for this afternoon for those interested to the Oxygen Plant at Maisonneuve, which is said to be exceedingly interesting, and Mr. R. J. Levy, the manager, has kindly undertaken to be here at 2.30 to conduct the party there.

Mr. Muckleston, of Calgary, sends a discussion on the report of the Committee on Roadbeds and Ballasting. I don't know whether it is in order to take it up until there is some member of the committee present.

THE PRESIDENT: Probably we had better leave it over for the moment. Is there any gentlemen here on the Committee for Roadbed and Ballasting?

MR. MACKENZIE: Mr. President, may I ask what you propose to do regarding this report?

THE PRESIDENT: Well, we want the report to be received, and if there is any discussion on it we will be glad to have it.

MR. MACKENZIE: Of course, I am not the chairman of that committee. I am simply a member of the committee and I am not authorized to present the report, but I have something to say regarding it, if it is in order.

THE PRESIDENT: Very well, it is now open for discussion.

MR. MACKENZIE: I think this is one of the most important reports that we have. I came here purposely to take a small part in the discussion of this report, and I may say that I am very much disapointed to find that the chairman of the committee is not present. I don't know whether or not there is any communication from him.

THE PRESIDENT: This matter came up the other day, and we postponed it until to-day. We have had no communication from the chairman of that committee.

THE SECRETARY: The practice has been to have any member of the committee who is present represent the committee.

MR. MACKENZIE: Since this is the case, is it in order that I should make a few remarks on this report before it it is received?

THE PRESIDENT: Certainly.

MR. MACKENZIE: I may say, then, Mr. President, that I heard nothing of this proposed specification until about a month before this meeting. I spent a couple of days going through it, and jotting down my views regarding certain points which are contained in it, which I sent to the chairman. The report, however, has been printed as it originally appeared, without any change whatever, and, as I said before, it is certainly a very important report, seeing that there is a great deal of railroad building being done in Canada at the present time, and I think it would be of very great benefit and convenience to all engineers engaged in railroad work that a standard specification should be adopted by this association. There are a great many different specifications in use at the present time on roadways, and this draft presented by the committee has been largely modeled on the standard accepted by the American Engineering Association, with improvements or supposed improvements sandwiched in here and there through it, producing what we have before us in this report.

Now, in comparing it with the standards as found in the 1911 Manual of the American Engineering Association, the first difference we find is in the marginal references. Here we have no marginal references at all. These are very convenient in actual work, and particularly if there is an index at the beginning of these marginal references. I think that these marginal references should be put on.

In paragraph 8, if you will kindly turn to it, it is stated:—

"Stumps shall be cut off even with the ground, where cleaning is to be done, except between the slope stakes of embankments, where they may be cut so that the depth of filling over them will not be less than 2½ beet."

Well, if that is carried out literally, you might have stumps there 17½ feet high. It seems to me that that requires revision.

Paragraph 11 says, "All trees that may be reserved shall be stripped of their tops and branches, made into ties, or cut to such lengths as may be directed and neatly piled up at such places on the right of way as may be designated, for which service payment may be made by the tie or by the cord of 128 cu. ft."

I think, Mr. President, with reference to that particular paragraph, that we should make it quite clear that the wood cut on the right of way belongs to the railroad company, and not to the contractor. These are little things, but they always come up in carrying out the work.

Now, if we are to make a specification as a standard, let us make it so clear that there will be no difference with the contractor when the work is being carried out.

In paragraph 12 it mentions that close cutting is to be included in the price paid for clearing. It seems to me that is not right. Close cutting should be paid for separately.

Paragraph 16 says: "Grubbing shall also be required between slope stakes of all embankments of less than 2½ feet in height."

In this paragraph the 2½ feet mentioned conflicts with the 4 feet mentioned in paragraph 18. That requires revision.

Paragraph 18 says that the payment for the grubbing shall be paid for separately. It seems to me it should be measured in square acres. The contractors understand square acres better than any other measure for that kind of thing.

The grubbing should be paid for as grubbing on excavation or anywhere else. It does not matter where the contractor does the grubbing, he ought to be paid for it. It is sometimes said that if a contractor takes out stumps with a steam shovel that he has no right to be paid for grubbing. That is not correct. It costs the contractors just as much to handle stumps with a steam shovel, as it does to grub them out anywhere else, because he has to handle them two or three times.

Am I going into too much detail, Mr. President?

THE PRESIDENT: We have a great deal of business to go through this morning, and I was going to suggest to you, that if the report is not satisfactory to you, Mr. Mackenzie, it should be referred back to the committee, because the committees themselves, before they present the reports, I understand, got together and agreed upon them.

MR. MACKENZIE: Well, it has not been agreed upon.

THE PRESIDENT: Well, had you not better move that it be not adopted but referred back to the committee again?

MR. MACKENZIE: Well, that would result in putting it a year back.

THE PRESIDENT: Well, as you are the only member of that committee present, it seems to me if we are going into it in detail, I do not know that we could do very much, because the other members of the committee may not look upon your ideas in the same way as you do, and it would be better if you are not satisfied with the report of the committee to have it sent back to the committee.

MR. MACKENZIE: These notes that I have been reading were sent to the chairman of the committee about three weeks before the meeting.

THE SECRETARY: Perhaps Mr. Mackenzie would give a general criticism with a motion that the report be referred back to the committee.

THE PRESIDENT: How would it do for you to make your suggestions in writing, which, of course, would make it necessary to have the report referred back for another year?

MR. MACKENZIE: I see nothing else than that. The report will have to be postponed for another year.

MR. MOUNTAIN: I quite sympathize with Mr. Mackenzie. I think we should have a finality to these things. (Hear, hear.) We are going on with these reports, and we all know that these reports are particularly useful to railway engineers, and we are now using—most of us who are railway men in this room—are using the American Railway Engineering Association standards. We prefer to use our own. This society has made standards and they are approved.

There is another one coming up shortly—the bridge specification. That committee was formed, I think, two years ago, and I understand to-day that it is to be brought up and carried over. Now, we are dealing to-day with half a dozen different specifications, and I for one would particularly like to see this matter closed up and some finality reached about these specifications.

THE PRESIDENT: How would it do, Mr. Mackenzie, to authorize this meeting to have these specifications adopted when they are revised, but not wait for another year.

MR. CLEMENT: The adoption of a standard specification by this society may debar certain members who are working under specifications of their own. I do not think the society should adopt the standard until all the members have had a chance to be present and discuss it. We have had brought before us a specification, and the only member of the committee present states that he took no part in that specification, and did not know it was being adopted by the committee. I would move, sir, that this report be referred back to the committee, and that it be brought before the various meetings of the sections and various branches for discussion, and that the result of these discussions be sent in in the form of suggestions to the committee for their consideration.

MR. DUGGAN: I entirely agree with the remarks of the last speaker. I think we ought to go further and revise our whole method of dealing with these reports. The matter was up in Winnipeg last winter and it was then agreed that the reports should be issued one month before the annual meeting, so that it might be discussed. As a matter of fact, we have at the annual meeting perhaps not over five per cent. of the whole membership of the society. There is a lot of other business to be attended to, and a report comes up. It is too long to be read over clause by clause, as it is in the other associations, and the thing is either adopted or rejected or sent back to the committee for continuance. I think that Mr. Clement's suggestion is an excellent one, that the report should be read by the various sections and got into shape and discussed by them, and I think we should go even further, and when a committee considers that a report has been discussed as far as possible, both before the various branches and by written communications, that they should issue a final report for letter ballot by the society. This society, stretched out as it is all over the country, can hardly deal with important matters in any other way than by letter ballot, and I do not think the time of this meeting can be taken up better than by passing a resolution to that effect. We should deal with these important reports coming up before us every year in a proper manner, and I have much pleasure in seconding Mr. Clement's motion.

THE SECRETARY: Might I say, for the information of those present, that as far as possible the resolution of the annual meeting at Winnipeg was carried out. The only reports which are presented here are those which were turned in a month before this meeting, and they were in the hands of the members—perhaps not a whole month—but about three weeks before the meeting. There are other committees who have not reported at all.

MR. MACKENZIE: There are just two suggestions that I wish to make before the discussion ends, with regard to the standard specifications. I intended to suggest that when this special specification is completed by the committee and before final adoption by the society as a standard, a copy should be sent to every member of the Canadian Society of Civil Engineers, giving him a month to reply, and to send in any suggestions or criticisms which he may wish to make by letter, to the secretary of the society. No one can then say he did not have a chance to say what he wanted to say about any standard specification, and further, I think it would be a helpful thing if a copy were sent to every one of our principal railway contractors in Canada, as some of these contractors have decided views with regard to these specifications, and I do not think it is quite fair that an engineer on one side and a contractor on the other side, who are associated in carrying out the work based on these specifications—I do not think it fair that the man who does the greater part of the work should have no say whatever in the specifications under which he is working. (Hear, hear.)

Some of these contractors are engineers as well as being contractors. Most of them are very intelligent men, and can give engineers pointers regarding the specifications, as well as the actual carrying out of the work every day in the week.

Now, I think we should have the secretary to ask the assistance of some of those contractors in preparing a standard specification which would be, I hope, a standard as long as we live.

THE PRESIDENT: Would it not be the proper thing for the members of the committee to send the information out to the contractors, and get their ideas before submitting a report?

MR. MACKENZIE: I think the society as a whole should, perhaps, request the committee to do that. It would carry more weight, and they might have very different opinions about the advisability of doing it. Some engineers know it all; the contractor takes what comes to him.

THE PRESIDENT: Of course the members of the committee would know better who the contractors are than probably the society at large.

MR. MACKENZIE: If the suggestion was made to them, I think it would be a great help to suggest that the committee do it.

THE PRESIDENT: Do you want to put your motion, Mr. Clement?

MR. CLEMENT: I do not know that my motion has been seconded.

MR. LEOFRED: It seems to me, Mr. President, that the Canadian Society of Civil Engineers should not overlook the remarks of the chief engineer of the Intercolonial Railway, who says to us very frankly that he has not been consulted, and that the committee, of which he is a member, never wrote to him stating what report they were going to propose for adoption. I believe, under the circumstances, we ought not to adopt this report without taking into consideration the very valuable remarks of the chief engineer of the Intercolonial Railway, whether in the form of a motion or otherwise. We should take his remarks into consideration.

THE PRESIDENT: Well, gentlemen, is it your pleasure that we dispose of this matter or leave it over for another year, by referring it back to the committee?

MR. DUGGAN: No, do not leave it over. It is too important.

MR. JAMIESON: This question of committees and the question of dealing with specifications is one that requires a great deal of consideration by this society. Now, if the society is going to issue specifications they should certainly be most carefully prepared and every point corrected before they are adopted by the society. That involves a very large amount of work by any committee, and that committee should have every consideration from the society, and should not be subjected to undue criticism, because there are many points that cannot be dealt with to the satisfaction of all; but one thing the committee should do, is to take care, I think, to have everything in as good condition as possible, and every clause carefully considered as widely as possible by the members of the committee as a whole after getting the advice of others wherever necessary. Then they should bring the report before the society and make their recommendations. After that the annual meeting may be able to deal with it to better advantage than we can in this way.

I understand it is quite impossible to discuss these reports clause by clause during our annual meeting, with the time we have at our disposal to do so, and unless we are going to devote the whole of the time to a discussion of the business affairs of the society, and cut out our trips around the city, and if these reports are not in such shape as to be above fair criticism, I think it might be well for it to be referred back to the committee for another year, with a view to getting them in that shape, and making final recommendations.

MR. MONSARRAT: Mr. President, I know in connection with the bridge specification, it has been very difficult indeed to get a discussion of the various clauses contained in it, on account of the committee being so widely separated all over the country, and, as Mr. Jamieson has said, there is a great field to be discussed and it takes a great deal of time. I think, therefore, it would help considerably if the committee would be furnished with a secretary who could look after the correspondence and the collating of information, and the resident members of the committee could discuss the matter and make suggestions. The secretary could see that these suggestions were forwarded to the outside members of the committee for their revision or suggestions and, after they had come to an agreement in the matter, then these reports could be submitted to the society as a whole, and written discussion sent in on them, or opportunities given to discuss them or bring up any point for the committee to discuss. Then the reports could be put in proper shape and submitted to the society at the annual meeting, which would thus eliminate a great deal of discussion at the annual meeting when there is very little time to do it properly.

MR. JAMIESON: I quite agree with the last speaker that when there are a number of committees dealing with these reports that there should be a secretary, who would act for all the committees, because it involves a great deal of research in connection with matters of specifications that the secretary could look up, and it is very difficult for the general members of the committee to get at it. The preparation of a specification is essentially a one-man job along with a secretary, and then it could be sent out to the other members of the committee for their revision or suggestions and concurrence after preparation, and then go through that final revision before being referred to the annual meeting.

THE PRESIDENT: At our annual meeting in Winnipeg we made provision for that, and we were given authority to spend money for that purpose.

MR. HARKOM: Instead of dealing with this special report, it seems to me that the discussion is taking a general form. As has been said here, I think it will be desirable to send out and get the expression of all the members before hand.

It seems to me that the act of putting out a specification by the society as authoritative and the society being responsible for a specification, should be very carefully considered. There is also the question as to whether the meeting, such as this annual meeting, is really properly qualified to dispose of such a subject. Would it not be better, Mr. President, that all committee reports, when they come in, should be dealt with by the Executive Council, and that they should not be issued as authoritative, but as recommended practice. Then again, it might be possible if that provision is made in that way, for a committee's report to be issued between annual meetings, and, if a secretary were appointed for that purpose, it could be sent out to all the members of the society who are interested and qualified to speak on the subject, and then the council might deal with it in a far more satisfactory manner than at a meeting like this.

MR. JAMIESON: Mr. President, pardon me if I again speak on the subject, but Mr. Harkom has raised a new point, and one that is very important; that is the question of sending in the report or specification for revision by the council. When we appoint committees at our annual meeting we are assumed to select for members of that committee those members of our society who are assumed to be best qualified to deal with the subject under discussion. If that is so, then that committee should be in a better shape to prepare their full report or make the specifications than the council is; and furthermore, they are appointed for that special purpose while the council has lots of other duties to perform. I think, therefore, it is essentially the work of the committee and not the work of the council.

It also raises the question as to whether those committees appointed at the annual meeting are committees of the whole society or committees of the annual meeting, or whether they are subservient to the council of the society—whether they should deal directly and report to the annual meeting or not. Of course all committees necessarily must work in concurrence with the council, because the council is the governing board of the society, but they should not be subservient to the society, nor have to depend on sending

in their report for revision to the council. Otherwise it would take away all sense of responsibility and pride that the members of that committee may have. I think we ought to know now exactly what is the standing of our committees.

THE SECRETARY: Mr. President, answering Mr. Jamieson, the procedure in regard to committees is quite definite, whether it is a proper one or not. It is this: The committees draw up their reports, when, in the opinion of the committees, the reports are ready they are sent in to the council, and the council is instructed by the annual meeting to send those reports out to the members for their information, and for any discussion they may wish to make. The reports are then supposed to be ready for consideration by the annual meeting.

MR. JAMIESON: Yes, but that does not involve the revision of any report by the council.

THE SECRETARY: No, certainly not.

MR. JAMIESON: I have raised this question because there are certain cases in which the council has, I think, stepped in where they have had no right to do so, and have interfered with the personnel of these committees. I do not wish to go into it any further, but it certainly is not right that it should be that way.

MR. HARKOM: It is not my intention to suggest that the Executive Council should be empowered with, or in any way to deal with, the report of the committees, confirmed by a ballot or referred to the society as a whole, but with the result that the committee's report should govern the council.

THE PRESIDENT: We are now discussing this report and nothing else, and I would like somebody to make a motion in regard to it, as to what we are going to do with this report on Roadbeds and Ballasting.

MR. JAMIESON: I move that the report of the Roadbed and Ballasting Committee be referred back to the committee for the incoming year, and I do this with a great deal of deference, because it is going to result in putting it over.

MR. SNYDER: I would move an amendment to the motion that the reports of committees, or every report, should be submitted to one special meeting of the society for discussion. It is utterly impossible to discuss so many reports at one single meeting, and if the reports on Bridge Specification are submitted at one meeting and nothing else, then we would have an interesting paper. It has been stated here that there are no interesting papers for discussion brought up in the society. These reports of committees are practically papers which are submitted to the society at the annual meeting, which could be submitted to one meeting and then they could be properly discussed, but I submit it is utterly impossible to do it properly at the annual meeting. Therefore, I move that the report of the committee be submitted to the society and be discussed at any meeting, but not at the annual meeting.

MR. DUGGAN: I understand, Mr. President, that you are dealing simply with this report of the Committee on Roadbed and Ballasting.

MR. JAMIESON: At the request of a member I add to my motion that it be referred back, and in the meantime, as early as possible, copies be sent out to all members for suggestions, and that as finally revised, be printed. If there is a demand for it, it may be issued in the meantime, of course, not as adopted by the society, but sent out for sug-suggestions.

MR. MACKENZIE: What I have asked Mr. Jamieson to include in his motion is, when the committee's report is made as good as they think they can make it, that they should send a copy to each member of the society and ask that member, within four weeks, to let them have the benefit of his suggestions or criticism, and that they should do that also in the case of prominent contractors who do such work.

MR. ST. GEORGE: Why not specialize the men to whom you would send it? For instance, a bridge report should be sent to bridge builders. It seems to me that would save a good deal of time.

MR. MACKENZIE: I mean to contractors in that particular line of work.

MR. HOLGATE: Is it not included in the Bulletin?

MR. JAMIESON: Well, that is the sense of the motion that I propose. I can write it out, if you like.

MR. McGOUN: I wish to second the motion.

MR. DUGGAN: I beg to move an amendment to the motion, adopting Mr. Clement's idea, namely, that this report be referred to the various branches, and that they be asked to discuss it, and report their discussion to the committee; and also, that every member should be asked by letter to send in their opinion or suggestions before the first of March, let us say, and that the committee should then deal with the suggestions and issue the report for letter ballot to the society.

If the matter is to represent practically a standard specification, it surely is a matter of sufficient importance to a lot of men who are at a distance to be given an opportunity to discuss it; it is merely a matter of dealing with the matter within the next two months in the same way as we would have to if it were referred back to the committee to be dealt with at the next annual meeting.

MR. CLEMENT: I second the amendment.

MR. JAMIESON: It seems to me there is very little difference between the amendment and the original motion.

THE SECRETARY: While the amendment is being prepared formally, there is a discussion from one member on this report. I have a communication from Mr. Muckleson, of Calgary, who sends in a discussion on the report of the Committee on Roadbed and Ballasting.

THE PRESIDENT: Had not that better be referred to the committee? Is that your pleasure?

Carried.

MR. SKAIFE: While the amendment is being prepared, there was a motion brought up the day before yesterday by Mr. Stead and it was duly seconded, and the meeting apparently took no notice whatever of it. I wish to bring that motion to the attention of the meeting now, and I would therefore move that in future the council form a reception committee to receive the outside members and see that they meet the local members of the society at every annual meeting.

THE PRESIDENT: I understood that Mr. Stead withdrew his motion at that time, and I stated that we would bring it up to-day as new business.

MR. JOHN KENNEDY: May I say just a word while the amendment is being prepared about these reports. I think it would be well if the Committee on Specifications would include in the specifications, as a specification only, those points upon which the engineers are pretty well agreed as a whole, and that the specification which may be considered as a standard specification, if adopted, should be accompanied by remarks upon recommended practice or variations under special conditions. In many instances variations are necessary for meeting special conditions, and remarks to that effect are very valuable.

I have in mind the specification of the American Society of Civil Engineers, and another of our own, which is all mixed up. The specifications proper and the remarks about what ought to be done in recommended practice, and what is done by the association for testing material in the United

States, are given, and there is an immense amount of valuable information in this, but it is utterly impossible to use it as a specification. One cannot refer to it and state that the work and materials are to be according to the specification of the Canadian Society of Civil Engineers, because it will not work as a specification, although it contains very much valuable matter. Now, if the specification proper were to include just such things as are standard and agreed upon for all ordinary occasions, and then be accompanied by an index with remarks upon recommended practice, or what is done under special conditions, it would be really more valuable and more easily workable. (Hear, hear.)

MR. DUGGAN: Mr. President, my amendment is as follows: That a notice be sent out requesting each of the branches to discuss this report and report the discussion to the secretary not later than the first of March. Also, that those who cannot attend the meeting be requested to send in written discussion before the first of March, and that the committee be requested to take such discussion into consideration and send out the report again for adoption by letter ballot not later than the first of June, such ballot to be returned not later than the first of July.

MR. SHERWOOD: Mr. Duggan's amendment seems to be in the right direction, but I think one important point is to get a discussion of the suggestions.

MR. TYE: It seems to me that the suggestion that these specifications and reports be discussed separately at a meeting, is a very valuable one. I think that personal discussion often brings out better points even than written discussion, and if this suggestion of Mr. Duggan's could be carried out and then referred to one of our ordinary meetings called for that purpose, it would be then discussed just as an ordinary paper would be, and I think you would get good information from discussion in such a way. (Hear, hear.)

MR. MACKENZIE: I see that the amendment has ignored the suggestion that prominent contractors in the same line of work should be given an opportunity to make suggestions or criticisms. If it is the sense of the meeting that that should be, I have nothing further to add. Otherwise I think it should be included in the amendment.

MR. DUGGAN: I did not intend to ignore that suggestion by any means. I think Mr. Mackenzie's suggestion is an excellent one. I should think the committee, in dealing with the specifications, would be only too glad to get ideas from contractors, and I would therefore amend my amendment that notice be sent out to members of the society as well as to the prominent contractors. Of course, it is a difficult thing to include it in the motion.

THE PRESIDENT: The resolution and the amendment are practically the same, with the exception of the word "contractor."

MR. TYE: I wish to put that suggestion of mine in the form of an amendment to the amendment, or perhaps Mr. Duggan, who seems to favor it, might include it in his amendment and not necessitate a further amendment being made.

MR. JAMIESON. Is it not in order for the society to call a meeting and have it discussed?

THE PRESIDENT: When?

MR. JAMIESON: Right away, or at any time.

THE PRESIDENT: Yes, I should think so.

MR. JAMIESON: I mean without a motion to that effect.

THE PRESIDENT: While the amendment is being prepared with the further suggestions that have been added, there is a resolution that has been moved by Mr. Skaife to the effect that hereafter at all annual meetings of this society a reception committee be named by the Executive Council who shall see that the outside members meet the local members. This is moved by Mr. Skaife and seconded by Mr. Harkom. What is your pleasure, gentlemen?

Carried.

MR. DUGGAN: My amendment will now read as follows: That notice be sent out requesting each branch to discuss this report and report the discussion to the secretary not later than the first of March. Also, that those who cannot attend the meeting be requested to send in a written discussion before the first of March. That the committee be requested to take such discussion into consideration and ask for a letter ballot on a final draft of the report, not later than the first of June, such ballot to be returned not later than the first of July.

THE PRESIDENT: You have heard Mr. Duggan s amendment, which has been seconded by Mr. Clement. What is your pleasure?

MR. JOHN KENNEDY: Does this amendment refer to all reports or to this special report?

THE PRESIDENT: To all reports.

Carried.

THE SECRETARY: Might I ask what would happen after the first of July?

MR. DUGGAN: The council will issue it.

MR. McGOUN: I think that all the members here present should have an opportunity of discussing this now.

THE PRESIDENT: Well, I have declared the amendment carried.

MR. McGOUN: The report of the annual meeting asks for discussion of all reports, and it seems now that all this discussion is cut out. We who have come here from a distance do not get an opportunity to discuss it.

MR. DUGGAN: I might say that I had no intention of cutting off discussion in making my amendment.

THE PRESIDENT: There is another important matter for discussion, and that is the proposal to sell our property. I will ask the secretary to read the communications that he has with regard to this project.

MR. SKAIFE: I would like to ask in this connection if there is a real estate broker's commission of two and a half per cent. to come out of the amount mentioned, or do we deal directly with the purchaser?

THE PRESIDENT: We do not pay any commission.

MR. TYE: I will be glad to move the necessary resolution. As I understand it, it is the case of a railway taking the property, and they can expropriate it if they see fit. It seems to me that this offer which we have obtained is a very good one, and we are not likely to get anything better.

MR. MARCEAU: I second the motion.

MR. OGILVY: As a matter of information, Mr. President, will you state what this property stands on the books of the society at the present time?

THE SECRETARY: A little less than $16,000.

MR. KEEFER: When do we require to vacate the premises?

THE SECRETARY: Theoretically on the 1st of May, but practically not for some time.

MR. KEEFER: Has the committee any other site in view that we can obtain?

THE PRESIDENT: Yes, we have two or three sites in view.

MR. KEEFER: Have you figured out how much it comes to by the square foot?

THE SECRETARY: It comes to a little over $20 a foot.

MR. ST. GEORGE: Is there interest to be paid on the other two instalments of ten thousand dollars?

THE SECRETARY: Yes, at six per cent.

MR. MURDOCK: Will it cost more or less than $60,000 to get the new premises.

MR. TYE: I think we should take this occasion to get a better site and a better house than we have now. This is getting a little small for us, and I think we could very well afford to take the $60,000 and put $20,000 or $30,000 more to it, and get a good place.

THE PRESIDENT: What is your pleasure, gentlemen, shall we approve of this sale?

Carried unanimously.

MR. SKAIFE: I would like to move in connection with this matter of securing new premises, that a building committee be named by the society for looking after the erection and procuring of a site. I think the council of the society has enough to do without looking after that matter exclusively, and I would like to name Mr. St. George on that committee. I cannot help remembering the services he did in connection with securing this site and building.

MR. ST. GEORGE: No, no; leave it to the council.

THE PRESIDENT: I think that had better be left to council.

MR. SKAIFE: All right.

MR. ST. GEORGE: It seems to me the council should be authorized by this meeting, if it is necessary, to purchase another property without coming back to the society for authorization, but I think we should give them authority now to make the purchase of a site which is satisfactory to the council, without coming back to the annual meeting. They have to do it, and there is no use calling upon the society again. I think we have confidence in the council, and that that matter should be left entirely in their hands.

MR. SKAIFE: I wish to second the motion.

MR. ST. GEORGE: I would add to my motion that the council be given such powers to spend the necessary money to erect a suitable building—a building that will be a credit to the society, even if we have to go in debt, because we could afford to go in debt, but my suggestion is that we should have something good, and something that will be a credit to the society. (Hear, hear.)

MR. TYE: Well, would it be necessary for the society to say how much money the council might spend in connection with this proposal?

MR. ST. GEORGE: Well, let us say not to exceed $100,000.

THE PRESIDENT: What is your pleasure, gentlemen, in connection with this motion?

Carried unanimously amidst applause.

PROFESSOR HAULTAIN: With all due deference to the mover and seconder of this motion, it seems to me you are passing a very serious matter, very casually. I repeat this statement as a non-resident of Montreal. I think that we outsiders who are not represented here should have something to say as to whether $100,000 should be spent on a building in Montreal.

THE PRESIDENT: The matter is not open for further discussion. The next order of business is the report on Railway Ties.

MR. TYE: Why not apply to this report the same procedure that we applied to the last report, and then we would not require any discussion here at all.

THE PRESIDENT: What is your pleasure, gentlemen?

Carried.

MR. MOUNTAIN: What about the bridge report?

VOICES: The same thing.

THE PRESIDENT: Is it your pleasure that Mr. Duggan's amendment apply to all reports of the different committees?

MR. DUGGAN: I must say that I made my amendment simply to deal with the report that was then before the meeting. I think it is a great mistake when men have come a long distance to discuss these matters that they should not have an opportunity to do so. If we have other business of importance to get through, let us dispose of it, and then we can go on and discuss the reports as long as we have time to do so; that is to say, let us resolve ourselves into a committee of the whole society to discuss these reports, because I do not think they should be disposed of in any such offhand manner as is now suggested.

MR. JAMIESON: I agree with Mr. Duggan that if the society is going to issue specifications there is scarcely any more important business that we have to deal with in order that they should be put out in proper shape, otherwise we should not put them out at all.

THE PRESIDENT: I quite agree with you.

MR. TYE: Well, don't you think that this method of dealing with them is going to reach that result? We have only an hour or so more to discuss these things and we cannot go through all these reports in that time. They are going to be discussed at the annual meeting; the only thing is to do the same as the Maintenance Society in Chicago does. If they are going to be taken up at the annual meeting, there is nothing else to do but cut out all our visiting, and if we are going to have these strictly business meetings, we will have to discuss the reports and nothing else, and give one-half the day to general business only, but it seems to me this other way of having the reports discussed by the different branches and finally sending out a letter ballot is a very good way, in view of the fact that we do like to take these excursions to the different places of interest in the city.

THE PRESIDENT: If we get through our business in time we can have some discussion on these reports. What is your pleasure regarding the motion?

Carried.

THE PRESIDENT: We have the report of the scrutineers and the Nominating Committee and several other matters now before the meeting.

MR. CHIPMAN: What is the first on the program?

THE PRESIDENT: We have now disposed of all the reports, Roadbed and Ballasting, Railroad Ties, Good-Roads, Sewage Disposal, etc.

MR. CHIPMAN: I was not aware that the sewage report had been disposed of.

THE PRESIDENT: Well, it was not quite settled, but I understand all these reports are being sent back to the committee.

MR. CHIPMAN: Until next year?

THE PRESIDENT: No, certainly not.

MR. JOHN KENNEDY: There is one question in connection with the sewage disposal matter that I would like to bring before the attention of the meeting, and that is, that the Senate of Canada has a bill on sewage disposal—a rather drastic one—and it will come before the House shortly, and the point is whether this society should take any part in that matter in any way, either official or unofficial, or through a committee, or in any other way. If our opinion is of any use at all, it is time to put it in. I confess to being somewhat puzzled along just what lines we should act. If we can do anything towards assisting the Senate, it seems to me it should be done at the present time. There is some danger of a law being passed which will be unworkably severe.

MR. MACKENZIE: What are we going to do with the Good Roads report? That was a very important report. We don't know that there are any imperfections in that report, or anything that requires revision.

(To be continued.)

BITUMINOUS ROADS.*

By Major W. W. Crosby.

It is not the purpose of the speaker to trace the history of bituminous road work from the early efforts of the Peruvians, nor even to review the work of this country for the past 40 years, but rather to touch merely on some of the points in it at present of so much common interest and, in so doing, perhaps to suggest a thought or two that may be of value in stimulating consideration and discussion of this important subject.

For surfacing roads—usually called "Streets"—in cities, the larger practice in the use of bitumen has been to use it in the form of asphaltic cement, such as in sheets or block asphalt pavements. Such pavements, under proper conditions, give good satisfaction at reasonable expense. The first cost of them varies between $1.50 and $3.50 per sq. yd., however, and in recent years an effort has been made to secure a similar surface, of even wider applicability, at reduced cost. Incidentally, success in this line would offer a much needed surfacing for filling the gap between the best macadam, cheap but sometimes of questionable satisfaction, and the rather expensive asphalt pavements referred to.

In this effort, the use of cheaper bitumens—such as the tars for instance—has been tried, and also new methods and mineral materials for the body of the pavement, cheaper than the graded hot sand required for the sheet asphalt. Much success has been had with naturally some failures. This work, as a whole, however, in the cities has been so like the development of the country roads along the same lines, and the distinction between a highly developed country road and a minor street in a city is so lacking in clearness that we probably may proceed, with this reference to city work, to the consideration of road work proper.

Bituminous roads constitute a modern development to meet both the actual needs under modern traffic and the desires of modern civilization for greater efficiency, comfort, satisfaction and better sanitary conditions. The advent of the motor vehicle has greatly changed the conditions under which a road existed. Good roads are in greater demand owing to the greater radius of action of the automobile. Smoother roads are more desired because of its sensitiveness —at its greater speeds—to slight inequalities of road surface. More cementitious surfaces are needed, due to its ability to destroy the bond of the stone surface, to cause internal friction and wear of the pieces of stone forming the crust, and to render the road thus more susceptible to the elements. And further, the dust, which formerly laid on a good road surface and which, when not too profuse, was not only not seriously objected to, but was of some actual value in the protection which it afforded the stones composing the road, has been violently brought to our attention by the motor—so violently and powerfully in fact that we are now well aware that, under recent conditions at least, the disadvantages, discomforts and unhealthfulness of this dust far outweigh any good it may formerly have possessed.

None of us believe that the remedy for this state of affairs is the abolition of the motor-vehicle. Most of us who do not possess one are looking forward to the day when we may, and most of those who already are fortunate enough to own one are anticipating the possession of two or of more.

So the remedy seems to be to cure the defects of the road. And the speaker wishes to here again repeat what he has frequently said before, i.e., there is no one "best way" nor one "best material." The decision as to method or material to be used must depend in each case upon conditions of traffic, availability of different materials, desires of locality, and probable changes of conditions during the life of the work decided on to be done. A clear recognition of this fact is important for good work and economy. It is somewhat surprising how often it appears to be overlooked even among those who would be expected to appreciate it most.

Let us suppose now that we have the improvement of a certain road contemplated and that the details have all been worked out except as regards the road surface itself: that there is no question but that as soon as the road improvement is completed, a considerable number of motor-vehicles will use the road daily, say, not less than 20 every 24 hours. Then there is no question but that the road should be treated with bitumen either during or immediately after the construction of the surface with gravel, shells or broken stone, if economical and satisfactory maintenance is to be had. The treatment may also be justified for other reasons.

There may be said to be three ways in which a road surface may be treated with bitumens. These are, The mixing method; the penetration method; the method of surface applications, after construction in the ordinary manner.

A choice of these methods depends, as before stated, upon conditions. Such choice may be largely affected by traffic conditions but it is not yet clearly established just what amount of traffic demand justifies a selection of one method from the others. We are acquiring information on this point and it is hoped it may soon be clearer.

Generally, however, the choice is largely affected by other considerations, such as of comfort, health and satisfaction to the users or abutters, and the speaker believes that in making the choice it is well to be on the safe side from all these viewpoints. It is almost inevitable that, once a road is well improved, the previous traffic records will become almost worthless except for historical purposes. Consequently he believes that apparent extravagance in the choice at first may often prove later to have been true economy.

Although the speaker referred to construction alone in the foregoing, the remarks apply equally well to reconstruction or to repairs to a road that has deteriorated beyond the point where a surface treatment can be safely expected to relieve the needs.

At this point the speaker must inject the remark that it is his opinion that reconstruction is often attempted when a thorough surface treatment is all that is needed—not true economy. He is convinced that in the near future the use of proper surface treatments will be far wider and of greater satisfaction than it has been up to the present.

Now, the Mixing Method, as the term is generally understood, consists of mixing with the mineral material composing the wearing course of the road a sufficient amount of bituminous cement. This mixing is usually done at a plant off the roadway itself and even perhaps some distance from the site of the work. The materials may be mixed either heated or at the normal temperatures of either or both according to the method and materials employed, and by hand or by machinery for the purpose as desired. The mixed material is then taken to its place, spread and rolled and then frequently given a flush coat of bitumen and grit and again rolled. Satisfactory results from this method cost from 30 cts. to $1.50 per sq. yd. over and above what would have been the cost of an ordinary modern water bound road under the same conditions. The advantages claimed for the mixing method include great uniformity of surface and of composition of same, maximum value of surface for materials used, economy in use of materials, maximum life of surface and economy of results. There seems to be no question but that the mixing method has proved capable of producing high class results. There is grave doubt if it has always

* Paper read before the American Association for Highway Improvement, Richmond, Va., November 21, 1911.

been the economical method to have followed, and there are many instances of its utter failure. The mixing method frequently involves a considerable investment for machinery and with its first cost has led to the development of the Penetration Method.

In brief, the Penetration Method consists of simply applying a coat of pitch to the wearing course of the road just before the binding of this course by dusting, watering and rolling as usually practised in modern water-bound work. The pitch may be applied cold if properly prepared, though it is usually used hot. After its application, the pitch is coated with grit and the road thoroughly rolled. The cost of the Penetration Method varies between 10 cts. and 50 cts. per sq. yd. above the cost of water-bound work under the same conditions, according to methods, materials and quantities of the latter used. The advantages claimed by its advocates include sufficient uniformity of surface, economy in first cost, economy in long run, simplicity of operation and avoidance of complicated and expensive machinery, not to mention freedom from interference by patent infringement claims.

There is no doubt but that high class results can be secured by the penetration method. There are plenty of records of failure, however.

The method of Surface Treatments is only applicable to road surfaces already finished under other methods, usually to old or new water-bound work. In brief, the method consists of cleaning the old surface to be treated so that it shall be free from all fine material and refuse, even to washing it with water if this be necessary. After such cleaning, and when dry and as warm as practicable, the pitch is applied, allowed to soak into the surface for a longer or shorter time, as the material used may demand, then covered with grit and rolled. The process of applying pitch and chips may be repeated immediately, or after an interval as may be necessary. Sometimes two or more applications of pitch and chips are necessary for satisfactory results, and the interval between applications may vary from a day or so to a year or more, depending on local conditions. The pitch may be spread by hand or machinery as convenient, and either cold or hot, as its character may permit.

The cost of Surface Treatments varies from 5 cts. to 20 cts. per sq. yd. The advantages claimed for this method include simplicity of work, economy of first cost and, in many cases, economy in long run, lack of serious interruption to use of the coal, ease of repairs and renewal. Unquestionably satisfactory results have been secured under the method of surface treatments, and the speaker believes this method offers an easy and economical way for the revivifying of a road about to otherwise need resurfacing at a far greater cost under old water-bound methods or under either of the other two methods of employing bitumen.

The earlier success of the Mixing Method and the consequent attracting of attention to this method led many road workers to rush into it, believing it to be a panacea for all the road ills they were familiar with. A little later its extravagance in many cases became apparent and the Penetration Method received some followers. Still later the unnecessary expense of even this method became apparent for many cases and the method of Surface Treatments developed. Unquestionably, each method has its uses and the proper selection of one for a particular case is the end to be aimed at. The sphere of action of each is merged with or overlapped by those of the others and it will be some time yet before they can be clearly separated. The method of Surface Treatments is particularly applicable to use on old roads, and as water-bound construction will predominate for the near future at least, so will Surface Treatments grow in use.

The speaker is unable to wholly agree with a statement that had been made elsewhere to the effect that "the water-bound road is a thing of the past." He is yearly building a hundred or more miles of water-bound road and looks for such work to be continued indefinitely, as there are many localities where dustiness is less objectionable than increased first cost. But as these water-bound roads develop traffic over them, and as their extent and age increases, there comes a time when treatment is demanded and then Surface Treatment with pitch is often most advantageous and satisfactory.

In each of the methods referred to, a variety of materials may be used. At the present time, except possibly in the case of certain asphalt used for pavement work, the critical characteristics of a bituminous material to insure its being satisfactory in use under any definite method or conditions are not settled. Gradually, experience with them is clearing up the problem, but it is likely to be some time yet, owing to the variety already available and new forms yearly coming out, before definite knowledge will be had. Such knowledge will, of course, be hastened by co-operative effort, such as this meeting, and careful co-ordinated records of work done, which records are already being collected by the Committee of the American Society of Civil Engineers. About all that can be said now is that certain materials will generally give good results; many materials will be satisfactory when properly used; some are extremely limited in their application; and some are practically worthless.

In the foregoing we have perhaps dealt mainly with the use of bitumens or pitches in connection with ordinary road materials. And it may seem that it all was toward the end of improving what would, in many cases, have been a fair road, or under earlier conditions have been an excellent road. There is, however, another large consideration for the wider use of bituminous materials in road work. By such use many materials otherwise unfit for road surfaces—such, for instance, as the harder sandstones, granites, flints, etc., without binding powers—can be most satisfactorily availed of a great bridge over the Shimonoseki Straits for railway bituminous materials, soft stone, oyster shells, marl and even sand, can be made to cheaply form a road surface that is both highly satisfactory and most economical in a great many instances. And again, by the use of a relatively light and cheap "carpeting" of pitch and stone chips on its surface, the speaker believes many, if not all, of the defects of concrete for a road surface will be overcome. If so, a large avenue is opened for progress toward satisfaction and economy.

The selection of proper methods and materials to fit the conditions is the particular province of the unbiased and competent expert, and should not be attempted by the inexperienced nor entrusted to an ignorant or prejudiced party unless failure in some feature of the work is to be expected.

The speaker wishes to briefly suggest two thoughts more:

The first cost of bituminous roads is not a correct basis for the proper comparison of either materials or methods. Desirable, even satisfactory as such roads may be, they, like all other roads, require also maintenance.

This maintenance means expense even though reduced from the earlier figures for such work. And such maintenance should be, with bituminous roads as well as with any others, prompt, sufficient and efficient.

A LARGE BRIDGE.

A Japanese bridge project contemplates the construction of a great bridge over the Shimonoseki Straits for railway and highway purposes, to replace ferry connection. The bridge would be at an elevation of about 165 feet above water, and its total length would be over 3,700 feet.

LETHBRIDGE SEWAGE DISPOSAL WORKS.

The following description of some of the main features of the Lethbridge sewage disposal works, now under construction, should be not only of Canadian but also of general interest. The design of the sedimentation tank is understood to be original, and possesses certain features which are intended to obviate the recognized objections to the ordinary septic tank form of construction.

Generally speaking, the works are designed in order to obtain a reduced character of sewage effluent amenable to disinfection at the lowest form of construction.

The city of Lethbridge is situated in southern Alberta, on the banks of the Belly River, a stream of considerable volume, which joins the South Saskatchewan River. The city obtains its water supply from the river, which also serves as a water supply for several large coal mining centres located below Lethbridge. The population is over 12,000, and the normal water consumption converted into sewage about 700,000 gallons per day. The city is sewered on the separate system, but a proportion of the rain fall enters the sewers from roofs and a small amount of subsoil water also enters the sewers.

There is one main outfall sewer for the whole system, which up to the present has discharged raw sewage into the Belly River about a quarter of a mile below the city intake.

The demand for sewage purification is caused by the large number of typhoid cases in the mining centres depending upon the river as a source of water supply below the point of sewage discharge.

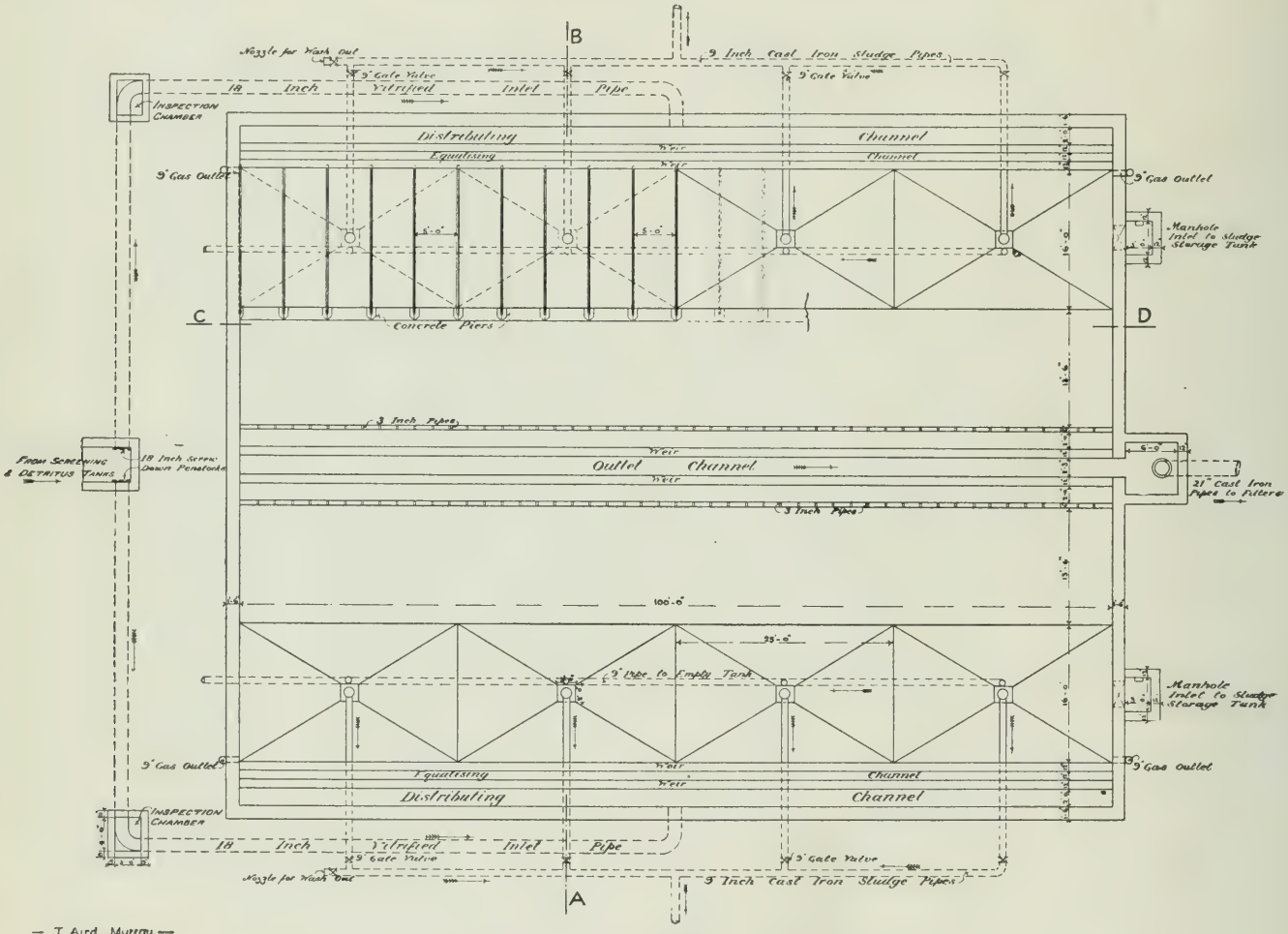
The discharge of sewage varies considerably at different periods of the day, and is only slightly affected by rainfall. Weir readings at the outfall sewer led to the conclusion that the proposed works be constructed to deal with and show a maximum rate of discharge of 2,000,000 gallons per day, a normal rate discharge of 1,000,000 gallons between 6 a.m. and 9 a.m., with a minimum rate discharge of 400,000 gallons per day between 9 p.m. and 6 a.m. Several of the water mains are composed of wood stave pipes, and much of the night flow is considered to be due to direct leakage from the mains to the sewers.

A series of analyses of samples of the sewage show it to be comparatively fresh at the point of discharge, the gradients being excellent and the distance of flow short. The average strength of the sewage is comparable with the class as described as weak in the fifth report of the Royal Commission on Sewage Disposal (Great Britain.)

Fortunately there is sufficient natural fall to allow of the sewage being treated before it enters the river without pumping.

Fig. 4 shows the general layout of the scheme, consisting of, 1st, detritus and screening tanks; 2nd, continuous flow sedimentation tanks; 3rd, percolating filters; 4th, humus tanks; 5th, chlorine mixing chamber.

The 1st, 2nd, 3rd and 4th stages of treatment may be said to be entirely subsidiary to the 5th stage, viz., that of disinfection. The preliminary methods are employed in order to ensure an effluent which can be disinfected at a high efficiency with a low annual cost. Experiments with refer-



—PLAN—

Fig. 1.

ence to the disinfection of the sewage tended to show: 1st, the difficulty of obtaining satisfactory disinfection without the removal of a large proportion of the solids; 2nd. That, in order to disinfect the settled sewage liquor after 70 per cent. of the suspended solids were removed there was required approximately 10 parts of chlorine per 1,000,000 parts of the sewage liquor; 3rd. That in order to disinfect the sewage liquor after it had been well oxidised and rendered chemically stable, it required approximately 3 parts of chlorine per 1,000,000; 4th. That, after oxidized liquor had stood for 1 hour for further sedimentation, that from 1½ to 2 parts of chlorine were required in order to obtain satisfactory disinfection. The above experiments were carried out with only small quantities of sewage and under circumstances which only allowed of very general conclusions. The general conclusions were so far in agreement with other experimental work of E. B. Phelps and others that they reasonably appeared to justify as follows:—

Supposing 2,500,000 gallons of sewage per day. To disinfect the liquor, after 75 per cent. of the solids have been removed, at ten parts of chlorine per 1,000,000 of sewage liquor, with chloride of lime at 1.5 cents per pound, the cost would be $4,000 per annum for lime only. To disinfect this sewage after thorough oxidation in filters and the removal of the filtrate humus, at 2 parts of chlorine to 1,000,000 of effluent, the cost would be $800 per annum. The difference in annual cost capitalized at 5 per cent. represents $64,000. Filters for oxidizing sewage at 2,500,000 gallons per acre at 6 feet 4 inches in depth can be constructed in Canada at a cost of $30,000 or $3 per cubic yard of filter material. There is thus a capital saving of $34,000 by adopting oxidizing filters rather than attempting to disinfect a putrescible effluent, on a unit of 2,500,000 gallon, sewage discharge.

The point where the capitalized cost would be warranted of disinfecting a putrescible sewage liquor rather than providing a non putrescible liquor by filtration followed by disinfection appears to be when only about 4 parts of chlorine are required for disinfection. The writer is strongly convinced that owing to the difficulty of penetrating even the finer solids and treating unstable sewage liquors with chlorine; that it will generally be found expedient to adopt what may be termed the standard methods of sewage disposal in order to obtain non putrescibility before disinfection is attempted.

Stress is laid upon the above point, for the reason that the proportion of dilution of volume of minimum flow in the Belly River to the sewage discharge, is away beyond that which is considered necessary to ensure oxidation by dilution.

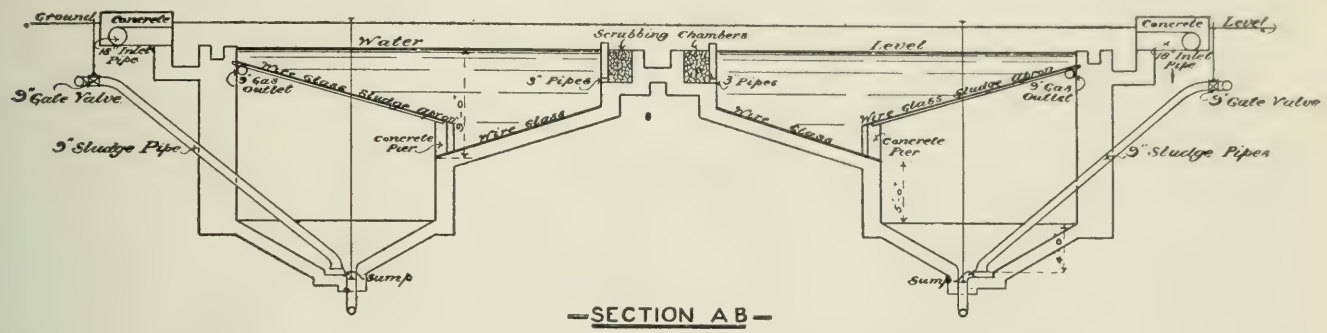


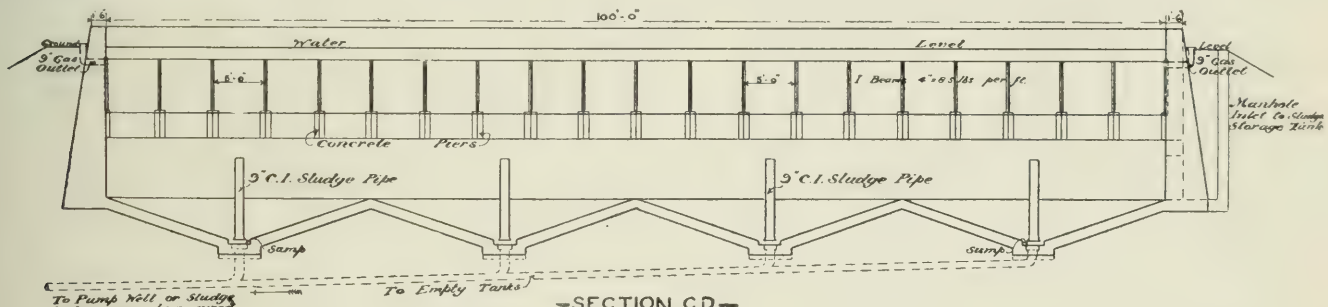
Fig. 2.

—T. Aird Murray—

Detritus Tanks.—These are built in duplicate, each 15'.0" x 8'.0" with a depth of 6'.6", with a total capacity of 10,000 gallons, providing a normal velocity flow of 1.7 feet per minute. Wrought iron upright screens are fitted across the tanks with ½ inch openings between the bars.

Sedimentation Tanks.—Are in duplicate as per figures, 1, 2, and 3. It will be noted that the sewage is delivered over a weir the full length of the longitudinal side of the tank. This is in order to obtain a low velocity of flow with as short a period of contact as is practicable, and is a departure from the ordinary custom in septic tanks of discharging the sewage over a weir the width of the cross section only and providing a considerable length of passage for the supernatent liquid over the settled matters. The settled sewage leaves the tanks by means of 3 inch pipes fixed below the sewage level and set at equal distances apart along the whole longitudinal length of the outlet and wall, thus ensuring that no floating matters pass off with the settled liquor. The settled liquor passes up and through scrubbing chambers of clinker before it enters the main outlet channel to the filters.

Each tank is practically divided into two compartments, as in the case with the Emscher Tank. A reinforced wired glass apron is made to project into the tank the whole



—T. Aird Murray—

Fig. 3.

longitudinal width. This apron covers what is called a sludge storage basin or area, and has a slope of about 1 in 5. The fore basin of the tank is also lined with glass with a similar steep slope. The apron overlaps the fore base and rests upon piers which are set intermittently allowing of openings between the sludge storage basin and the main body of the tank.

The working principle aimed at is, that, by means of the low velocity of flow owing to the wide cross sectional area of tank, precipitation of the solids will take place upon the apron and the fore base and that owing to the steep slopes and the minimum of friction presented by the glass surface, the precipitated solids will continually be delivered into the storage area or basin. In this basin putrefactive decomposition may be allowed to take place, with the result that such action will be entirely separate from the flowing supernatent fresh sewage The gases arising from decomposition will rise and impinge upon the lower surface of the apron and will be carried off by vent pipes to the outside of the tank, as shown. The many advantages of a decomposed sludge will thus be obtained without the admitted disadvantages resulting from sludge decomposition in contact with fresh flowing sewage.

Several of the above types of tanks are being constructed under the writer's direction in Canada and one installa-

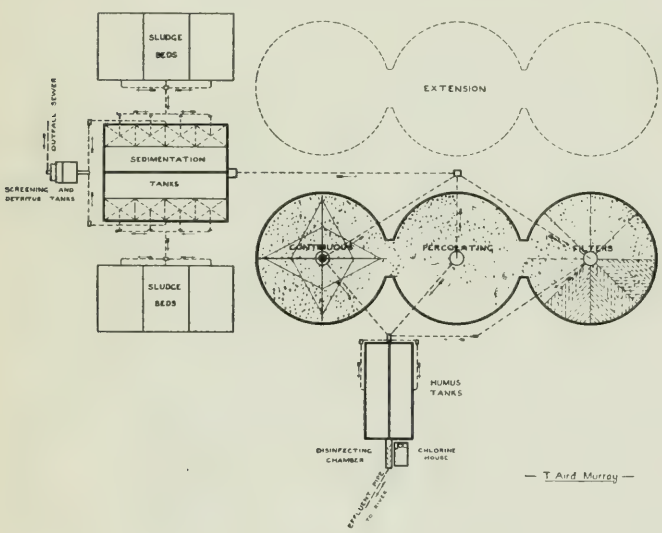


Fig. 4.

tion has been in use for some time, and although apparently giving excellent results, has not yet been in operation long enough in order to provide opportunity to obtain official and reliable data. The type of tank although similar to the Emscher as far as the objects aimed are concerned was designed before the Emscher was known in Canada, and no data as to comparative efficiencies as yet exist. The Lethbridge tank, however, is not costly as far as construction is concerned, and the principle of the glass apron appears eminently suited to a retangular form of tank for covering a sludge storage basin separated from the main body of the tank.

The sludge storage capacity in each tank up to the level of the lip of the forebase is equal to 60,000 gallons, while the sedimentation capacity is equal to 100,000 gallons. The velocity of flow through the tank is at the rate of .002 feet per second at the normal rate of flow of 1,000,000 gallons per day, and twice that velociy at the maximum rate of flow.

Filters.—The settled liquors from the above tanks is distributed over circular percolating filter beds, there being three in number each 108 feet diameter, with a depth of 7 feet of clinker graded from 2 to 3 inch cubes. The rate of filtration at the normal flow is 140 gallons of sewage per cubic yard of filter material.

The distributing apparatus consists of revolving distributors actuated by 2'.0" head difference between the level of the sewage in the tank and the level of the filter material in the beds. The distributing apparatus and other special mechanical appliances are designed and supplied by Messrs. Adams & Co., hydraulic engineers of England. The sub drainage of the filters is conveyed to the centre of each bed and from thence to humus sedimentation tanks.

Humus Tanks.—These are in duplicate each 80'.0" x 15'.0" average depth of 4'.0" with a total capacity of 60,000 gallons and a normal velocity of flow of .005 feet per second. As in the case of the sedimentation tanks the influent is distributed over a weir the full length of the longitudinal section, but no sludge apron or sludge storage basin is provided.

Disinfecting Plant.—This consists of a brick built house for lime storage, mixing tanks and head orifice tank regulated to the volume of flowing sewage. The hypochlorite mixes with the sewage in a chamber 26'.0" x 4'.0" wide with baffles placed every three feet.

In laying out the plant one of the main considerations has been compactness, as all the tanks and filters are to be covered and rendered frost proof.

Most of the work has been let by contract, the city supplying the clinker. The total cost is estimated at about $80,000.

The direct supervision of the work is under the control of Mr. A. C. D. Blanchard, the City Engineer, while Mr. T. Aird Murray of Toronto, as consulting engineer, is responsible for the design and layout of the scheme.

CONTRACTS FOR THE SUPPLY OF ELECTRIC POWER FROM THE USER'S POINT OF VIEW.

V.

BY H. E. M. KENSIT, M.I.E.E.

The next points to be defined are:

(1) Nature of supply.
(2) Regulation as to voltage and frequency or cycles.
(3) Equality of load on the phases.

"Nature of the supply" should define whether it is to be 1, 2 or 3 phase or otherwise, and also the normal load and normal frequency at which the power is to be delivered.

"Regulation" should define what variation is permissible from normal voltage and frequency and what steps are to be taken if this is exceeded.

"Equality of load on the phases" refers to the arrangement of the load in the customer's works. Two phase supply requires 4 wires and gives 2 circuits. Three phase supply requires 3 wires and gives 3 circuits, and there are other combinations which need not be fully discussed here. The customer's load should be so divided amongst these circuits in his works as to be approximately equal and similar on each circuit; otherwise the regulation and efficiency of distribution will be interfered with. A want of such balance in any individual works affects not only that works but the whole of the Power Company's system.

Sample clauses on these points are as follows:—

(1) "The power supplied shall be 3 phase electric energy at 600 volts and a frequency of 60 cycles, and the wave form of the alternating current shall closely approxi-

mate a sine curve. If either voltage or frequency vary by more than 5 per cent. from that above specified for more than 10 per cent. of each consecutive 24 hours the Power Company will instal more effective regulations.

"The customer agrees, that so far as the nature of its work will permit, it will so regulate its use of electric energy that the load will not vary suddenly more than 20 per cent., and that they will maintain equality of load on the phases within 10 per cent. of the load on the least loaded phase.

"The Power Company shall not be responsible in any way for the distribution of the electric energy or power beyond the point of delivery to the customer."

The insertion of the sentence relating to "wave form" is of very doubtful utility. The point is a highly technical one requiring a mathematical explanation that would be outside the scope of this article. The "wave form" depends on the design of the generating plant and on the nature of the load and cannot be said to be under the practical control of either the Power Company or the customer.

(2) "The Power Company agrees to deliver 3 phase alternating commercially continuous 24 hour power every day of the year except as hereafter provided and in the quantities above provided, at approximately 12,000 volts and approximately 25 cycles per second frequency, and the maintenance by the Power Company of approximately the agreed voltage at approximately the agreed frequency shall constitute the supply of all power involved herein and the fulfilment of all operating obligations hereunder. When voltage and frequency are so maintained, the amount of power, its fluctuations, load factor, power factor, distribution as to phases, and all other electric characteristics shall be considered to be under the sole control of the customer."

It may be pointed out that the use of the word "approximately" is undesirable, and it is better to state a fixed percentage even if this is very liberal. In case of a dispute or legal action it is as difficult to decide what is "approximate" as what is "reasonable."

(3) "The electric energy to be delivered under this agreement shall be 3 phase, 60 cycle, 2,200 volt, alternating current, and the Power Company agrees to maintain normal frequency and voltage within 2 per cent. either way. The customer will endeavor to maintain equality of phases."

Here it may be remarked that it is extremely doubtful whether any Power Company ever has or ever will be able to maintain voltage and frequency within 2 per cent. of the normal, and it is questionable whether such a requirement could be enforced. It is better to place this at a reasonable figure, say 5 per cent., and then insist upon this being lived up to.

Variations of voltage and frequency directly affect the speed of motors, and variation of frequency also affects the power factor of the motors quite appreciably.

Such variations are more frequently downwards than upwards, due to overload of the generators or transmission line or insufficiency of power.

Lowering the voltage and thereby the speed of the motors directly affects the amount of output of the factory, and in some cases its quality, and lowering the frequency lowers the power factor, and thereby in some cases increases the amount charged for power.

The power-user should therefore keep careful watch that both voltage and frequency are kept continuously within the defined limits.

All three of the points defined at the commencement of this article can be contained in one clause, and the following is suggested as the basis of a fair clause, subject to modification to meet the particular conditions:—

"The Power Company shall supply 3 phase electric energy at a normal pressure of 600 volts, and a normal frequency of 60 cycles per second. If either voltage or frequency vary by more than 5 per cent. either way from the above stated normal pressure and frequency for more than 5 per cent. of the time in any consecutive 24 hours, the Power Company shall immediately install more efficient regulating apparatus or take such other steps as may be necessary to keep the pressure and frequency within the above defined limits. The customer agrees that he will maintain equality of load on the phases of his circuits within 10 per cent."

This clause contains a guarantee by the Power Company and a guarantee by the customer. To be effective a penalty for non-performance should be provided in each case. This might be done by providing that the amount of the account for power should be deducted from or added to in proportion to the extent to which the above limits are exceeded.

Such variations represent a cash loss; in the case of voltage and frequency the loss is to the customer in affecting the quantity and sometimes the quality of his output and lowering the power factor of his load; in the case of unequal loading of the phases the efficiency of distribution is diminished and the operating difficulties increased to the disadvantage of the Power Company; it therefore appears fair that an adjustment of the account proportionate to such variations or inequalities should be made and should work both ways.

REGISTRATION OF MEMBERS OF CANADIAN SOCIETY OF CIVIL ENGINEERS.

The following members registered too late for inclusion in the daily issue of January 26th:—

240. F. E. Bremner, Montreal.
241. A. Bertram, Dundas, Ont.
242. J. Zverina, Montreal.
243. D. MacPherson, Ottawa.
244. E. B. McLean, Moncton, N.B.
245. G. W. Shearer, Montreal.
246. W. Murdoch, St. John, N.B.
247. F. Thomson, Montreal.
248. W. H. Greene, Montreal.
249. J. Mayer, Montreal.
250. H. C. Lumsden, Toronto.
251. C. Thomson, Montreal.
252. R. W. Leonard, St. Catharines, Ont.

PERSONAL.

Mr. J. J. Antonisen, of Port Arthur, has been appointed city engineer of Moose Jaw, Sask.

Mr. J. Stoddart has severed his connection with the city of Toronto. He has been appointed assistant engineer in the waterworks department of Hamilton, Ont.

OBITUARY.

Mr. Matthew Neilson, a well-known civil engineer in Canada, died on January 21st at his residence, 52 Arlington Avenue, Westmount, Montreal, after an illness of three months. Mr. Neilson was born at Almonte, Ont., 59 years ago. He is survived by a widow and one son. His death was due to pleuro-pneumonia.

FORESTRY CONVENTION.

The program for the big Forestry Convention, at Ottawa, February 7th and 8th, is now complete. The subject of how to handle our forests so as to get the most out of them, both now and in the future, will be dealt with by leaders from Canada and from the United States. Among those who will speak are Messrs. Gifford Pinchot, formerly Chief Forester of the United States; E. A. Sterling, Forester of the Pennsylvania Railroad, which is now growing its own ties; Dr. Fernow, head of Forestry School, of Toronto University; Dr. J. W. Robertson, of the Conservation Commission, and H. R. MacMillan of the Forestry Branch of the Department of the Interior. The banquet on Wednesday evening will be attended by parliamentary leaders, educationists, foresters, lumbermen and the heads of financial and commercial institutions. The day sessions are open to the public, and the importance which the government attaches to this subject is shown by the fact that these are held in the Railway Committee room of the Parliament Buildings; while the railways have granted special rates to delegates. The Seed Growers' Association convene on February 8th and 9th, so that delegates to the Forestry Convention will be able to attend some of the sessions of that body.

COMING MEETINGS.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Jan. 24. 25, 26, 1912. General meeting. 413 Dorchester St. West, Montreal. Prof. C. H. McLeod, Secretary.

CANADIAN FORESTRY ASSOCIATION.—February 7th and 8th, 1912. Forestry Convention Meetings held in the Railway Committee Room, Parliament Buildings, Ottawa. Secretary, Mr. James Lawler, Canadian Bldg., Ottawa.

CANADIAN LUMBERMEN'S ASSOCIATION.—February 6, 7 and 8, 1912. Annual Meeting to be held at the same time and place as the Canadian Forestry Association.

CANADIAN NATIONAL ASSOCIATION OF BUILDERS. — The Sixth Annual Convention will be held in Toronto, February 20, 1912.

ONTARIO GOOD ROADS ASSOCIATION.—Annual Convention to be held at Toronto, February 26, 27, 28. Secretary, J. E. Farewell, Whitby.

THE CLEVELAND ENGINEERING SOCIETY.—Regular Meeting, Tuesday Evening, February 13, 1912, Chamber of Commerce Bldg., Cleveland, O. Address by Mortimer E. Cooley, Dean, Department of Engineering, University of Michigan; Subject: "Public Utilities and Their Relation to the Public." Secretary, F. W. Ballard.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King's Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secretary, Mr. Heal, Moose Jaw

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary. H. Mortimer-Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, T. A Starkey, M.B., D.P.H., Montreal. Secretary, F. C. Douglas, M.D., D,P.H. 51 Park Avenue, Montreal.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary, R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

TENDERS PENDING

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page
Arcola, Sask., schoolhouse	Feb. 1.	Jan. 18.	75
Calgary, Alta., bridge	Feb. 10.	Jan. 18.	86
Chesley, Ont., public wharf	Jan. 31.	Jan. 18.	75
Grandview, Man., scrapers	Feb. 1.	Jan. 18.	75
Hamilton, Ont., works supplies	Feb. 6.	Jan. 25.	59
Lajord, Sask., schoolhouse	Feb. 10.	Jan. 25.	59
Little Lameque, N.B., wharf	Feb. 14.	Jan. 25.	59
Lake Quinze, Que., dams and sluiceways	Feb. 15.	Jan. 25.	59
Lloydminster, Sask., public building	Feb. 7.	Jan. 25.	59
Lion's Head, Ont., lighthouse tower	Feb. 5.	Jan. 18.	75
Ottawa, Ont., iron posts	Jan. 31.	Dec. 21.	68
Ottawa, Ont., contracting machinery	Feb. 26.	Jan. 11.	59
Petewawa, Ont., improvements to wharf	Jan. 31.	Jan. 18.	75
Saskatoon, Sask., subway	Feb. 23.	Jan. 25.	68
Saskatoon, Sask., pavements	Feb. 16.	Jan. 18.	86
Saskatoon, Sask., concrete sidewalks	Feb. 16.	Jan. 18.	86
Swift Current, Sask., theatre	Feb. 16.	Jan. 25.	59
Toronto, Ont., bridges	Jan. 31.	Jan. 18.	75
Toronto, Ont., Central Y.M.C.A. building	Feb. 5.	Jan. 25.	60
Toronto, Ont., track intersections, etc.	Feb. 20.	Jan. 25.	72
Upper Salmon River, N.B., pier	Feb. 14.	Jan. 25.	59
Victoria, B.C., schoolhouse	Jan. 31.	Jan. 18.	75
Walkerton, Ont., bridge, Saugeen River	Jan. 23.	Jan. 4.	59
Winnipeg, Man., electric vehicle	Feb. 1.	Jan. 18.	75
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., pumping machinery	Mar. 1.	Jan. 25.	72

TENDERS.

Calgary, Alta.—Tenders for sluice gates will be received by A. S. Dawson, chief engineer, C.P.R. Irrigation Department, Calgary, until February 29th, 1912. (See advertisement elsewhere in Canadian Engineer.)

Galt, Ont.—Tenders will be received until February 24th, 1912, for the construction of a building for the Young Men's Christian Association, on Queen's Square, Galt. Plans and specifications may be seen at the office of the General Secretary, William R. Cook, of the Young Men's Christian Association, Water Street, Galt, Ont.

Halifax, N.S.—L. Fred Monaghan, City Clerk, will receive tenders until February 1st, 1912, for 4,000 ft. 2½-in. fire hose, and 300 ft. 1-in. chemical hose, all with couplings complete and suitable for Halifax Fire Department.

Kerrisdale, B.C.—Tenders will be received until February 19th, 1912, for the supply of valves, hydrants and special castings, for the Corporation of Point Grey water supply. Specifications, etc., at the office of the engineers, Messrs. Cleveland & Cameron, 506 Winch Bldg., Vancouver. H. Floyd, C.M.C., Municipal Hall, Kerrisdale.

Lethbridge, Alta.—Tenders will be received until February 15th, 1912, for the construction of an extension to power house, plans and specifications of which may be obtained from A. Reid, General Supt., City Hall, Lethbridge. G. W. Robinson, Secr.-Treas., Lethbridge.

London, Ont.—Tenders will be received until February 14th, 1912, for one 50 h.p. gas engine, one gasoline engine, two half-million gallon triplex pumps, three deep well pumps, etc. F. W. Farncomb, Consulting Engineer, London. (See advertisement elsewhere in Can. Eng.)

Ottawa, Ont.—The Dept. of Public Works will receive tenders for the construction of a wharf at Cap St. Ignace, Que., until Feb. 5th, 1912. Plans, etc., at the offices of A. R. Decary, P.O. Bldg., Quebec; J. L. Michaud, Merchants Bank Bldg., St. James St., Montreal.

Ottawa, Ont.—Tenders will be received until February 24th, 1912, for the construction of five twin-screw gasoline launches for the Fishery Patrol Service of the Maritime Provinces of the Dominion of Canada, of the following dimensions:—

Length over all	45 feet.
Breadth moulded	11 feet.
Mean load draft	3 ft. 2 in.

Each boat to be equipped with two 16-h.p. gasoline engines. Plans, etc., can be obtained on application from the Purchasing and Contracting Agent, Marine Department, Ottawa. Agents, Marine Department, St. John, Halifax and Charlottetown. A. Johnston, Deputy-Minister of Marine and Fisheries, Department of Marine and Fisheries, Ottawa.

Ottawa, Ont.—Tenders for the construction of an extension to East Breakwater, and removal of L on West Breakwater, and dredging of Meaford, Grey County, Ontario, will be received until February 26th, 1912. Plans, etc., can be obtained at the offices of H. J. Lamb, District Engineer, Windsor, Ont.; J. G. Sing, District Engineer, Confederation Life Building, Toronto; Postmaster at Meaford, Ont., and at the Department of Public Works, Ottawa.

Winnipeg, Man.—Tenders will be received until February 14th, 1912, for extending the piers and abutments of the Red River Bridge, Winnipeg. Plans, specifications and forms of proposal can be seen at the office of Frank Lee, Division Engineer, Winnipeg.

Sudbury, Ont.—Tenders will be received until 1.00 p.m. February 5th, 1912, for the furnishing and installation of 2 return tubular boilers 72 in. x 18 ft. with accessories; also for 2 horizontal compound duplex steam pumps, 900 Imperial gallons capacity each; also one twelve-inch Venturi Water Meter. J. G. Heney, Esq., Mayor.

Toronto, Ont.—Tenders will be received until March 2nd, 1912, for the construction of 12 concrete bridges in East Whitby Township, Ont. Engineers, Bowman & Connor, 36 Toronto Street.

Winnipeg, Man.—Tenders will be received until February 8th, 1912, for the supply and installation of 3-50 K.W. transformers and accessories at Well No. 3, specifications, etc., of which may be obtained at the office of the City Engineer, 223 James Ave. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Victoria, B.C.—Tenders for the erection and completion of a five-room two-cell lock-up and constable's quarters at Quathiaski Cove, Valdes Island, in the Comox Electoral District, B.C., will be received till February 7th, 1912. Plans at offices of Government Agents, Cumberland and Nanaimo; the Constable-in-Charge, Quathiaski Cove, and the Dept. of Public Works, Parliament Bldgs., Victoria.

CONTRACTS AWARDED.

Calgary, Alta.—Messrs. McDougall & Foster have closed a contract for the erection of an apartment building to cost $250,000, to be erected at the corner of Jasper Avenue and Twenty-third Street, Edmonton, Alta.

Point Grey, B.C.—Contractors MacAdam & Co., of Vancouver, have the contract of the construction of a vitrified brick sewer on West Boulevard. Cost, $27,412.

Quebec, P.Q.—Mr. M. Connelly, of Montreal, has been awarded the contract to lay the Quebec water mains. Messrs. R. Maclaren Company of Glasgow will supply the fittings. This is the largest cast-iron pipe contract ever awarded in Canada ($532,000.)

Victoria, B.C.—The contract for the construction of the new six-story fireproof rooming house on Johnston Street for Messrs. Chas. Hayward and F. S. Barnard, has been awarded to the Westholme Lumber Co. The plans provide for stores with commodious basements on the ground floor, the upper portion to contain 100 good-sized rooms, each provided with hot and cold water, bath room, etc., and each furnished with telephone. The entire building is to be heated with steam, and electric lighted throughout, while an elevator in the main entrance will provide easy access to every flat. The entire cost of the building is $112,000.

Victoria, B.C.—The owner, P. R. Brown, has let a contract for about $14,000 to the Westholme Lumber Company for alterations to the premises on Douglas Street, between Fort and Broughton Streets.

Walkerton, Ont.—The Hunter Bridge Co., of Kincardine, have the contract for the erection of a steel bridge over the Saugeen River, Brant Township. James Warren, Engineer-in-charge.

RAILWAYS—STEAM AND ELECTRIC.

Brantford, Ont.—The Dominion Railway Board has approved the general location of the Lake Erie and Northern electric line to Port Dover, Ont.

Province of British Columbia.—The Dominion Railway Commission have approved the plans submitted by the Esquimalt and Nanaimo Railway Company for its extension up the east coast of Vancouver Island from Union Bay to Duncan Bay, the latter a point north of the Campbell River. It is understood that a very early commencement of construction is contemplated by the compnay, the clearance of right-of-way and a beginning of the grading of the line being already in hand. Large terminals are contemplated for Duncan Bay.

Edmonton, Alta.—Two petitions were brought before the house for the incorporating of street railway companies, one in Medicine Hat and another to serve several of the Crow's Nest towns. The Crow's Nest Pass Street Railway Company wants to operate lines from Cowley, west through Lundbreck, Burmis, Passburg, Bellevue, Frank, Blairmore, Coleman, to a point near Crow's Nest Lake. Those promoting the scheme are given as W. A. Beebe, Robert Coulthard, and Thomas B. George, all of Blairmore. The company is capitalized at half a million. Bonds may be issued to the extent of $12,000 a mile, and work is to start within two years and be completed in five. The Medicine Hat Railway Company's petition was brought in on behalf of Albert F. Krappel, David W. Brown and Warren Overplank, all of Medicine Hat. They are asking for the right to operate lines within Medicine Hat and suburban lines, including Dunmore and south-east to Elkwater Lake.

Montreal, P.Q.—It is stated that by early spring another railway, the Central of Canada, from Montreal to Ottawa, will be under construction, the contracting firm, Messrs. C. J. Wills & Sons, of London, being represented in this city by Mr. David Lyell. Orders are now being given for all the ties needed, as well as for the steel rails which are to be eighty pounds to the yard. It is said that a double track will be laid from Montreal as far as St. Eustache. The construction of three heavy bridges at the Back River, St. Eustache and at St. Andrews will be commenced when the spring opens, and by fall most of the masonry will have been placed in position. The entrance into the City of Montreal has not yet been disclosed by the company.

New Waterford, N.B.—The Dominion Coal Company have under construction at Carney's Lake, near New Waterford, a new electric power station to supplement their central electric power plant at Dominion No. 2. The work is being done by the company's construction staff, under the direction of Superintendent J. S. White.

Ottawa, Ont.—A report states that Hon. C. J. Dougherty, minister of justice, announced that the government has decided not to disallow the legislation of the Alberta Government in regard to the Alberta and Great Waterways Railway. The Provincial Government passed a bill taking over the $7,000,000 raised by the company on its bonds, and disallowance was asked for the reason, that it would be against established precedent to disallow such legislation, the rule having been established that it is inadvisable to interfere with the provinces in the administration of purely provincial affairs. Steps will be taken, it is understood, to see that the interests of those who have claims against the province are protected.

Province of Saskatchewan. — A network of railways to connect all four of the cities of the province with the Hudson Bay Railway is the evndent intention of the Canadian Northern Railway, according to a petition to be presented to the legislature.

Saskatoon, Sask.—During an attempt to wreck the C.P.R. train from Winnipeg to Edmonton, a bridge 93 miles west of Saskatoon was burnt by some persons unknown.

Saskatoon, Sask.—The city council approved the plans submitted by A. G. Sangster, electrical superintendent, to install three hundred and fifty-five light Tungsdon standards on the principal business streets of the city.

Western Canada.—W. B. Lanigan, general freight agent of the C.P.R. has been in St. Paul to borrow motive power to move from Fort William and Port Arthur 3,000,000 bushels of wheat still unmoved, which was ordered out for January delivery. He was negotiating with Great Northern and Northern Pacific Railways.

LIGHT, HEAT AND POWER.

Berlin, Ont.—The Light Commissioners have the following for sale:—One Westinghouse Gas Engine, size 19 x 22, 250 h.p., direct connected to 150 k.w. 3 phase 60 cycle 2,200 volt generator; also direct connected exciter. One 3 cylinder vertical Westinghouse Gas Engine, rated 90 h.p., size 10 x 11. Three 3 cylinder vertical Westinghouse Gas Engines, 125 h.p., size 13 x 14. One Tandem Compound Wheelock Engine 10 x 18 x 28, rated 125 h.p. Also a number of motors and generators.

Fredericton N.B.—The city council are to make an effort to secure a capable official to take charge of the electric light plant.

Carmangay, Alta.—The council have received word that the engine and boiler for the waterworks and electric light plants had been shipped. In two or three weeks the electric light plant should be in operation.

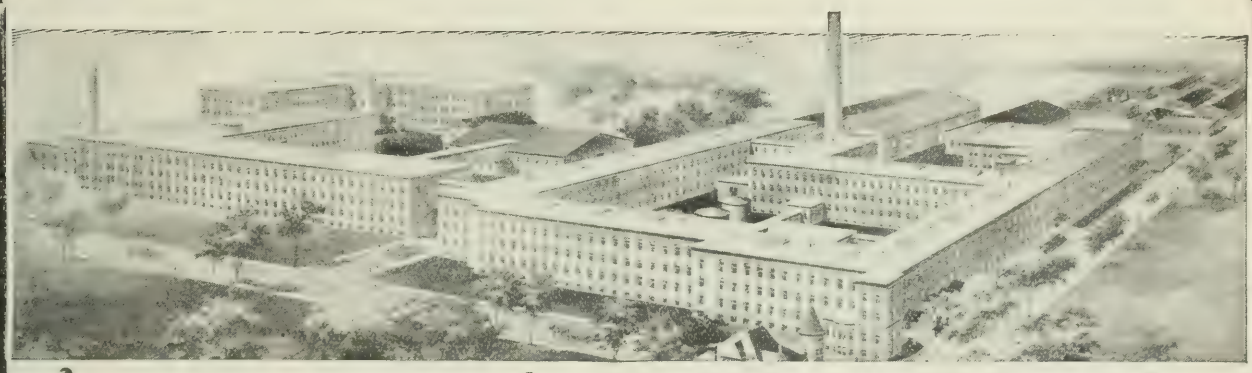
Port Arthur, Ont.—The work on the new street lighting system has been held back owing to the extreme cold weather.

Stave Falls, B.C.—The first large unit installed by the Western Canada Power Company, Stave Falls, B.C., was started on the 16th of December last. The putting into operation of this largest unit installed in Canada (excepting to Niagara Falls), went on to the greatest satisfaction and no irregularity whatever was experienced. No adjustment whatever was necessary, and the turbine was not again shut down. The present installation comprises two units of 13,000 horse-power, each working under a head of about 110 feet. The hydraulic equipment is supplied by Messrs. Escher Wyss & Company of Zurich, Switzerland. Canadian office, 408 Lumsden Building, and the electrical end by the Canadian General Electric Company of Canada.

Tweed, Ont.—The Tweed Electric Light and Power Company, controlled by the Messrs. Kisack Bros., have sold out to the Tweed Electric Light and Power Company, Ltd. The Electric Power Company of Toronto have the controlling interest, and new developments will take place in the system during the spring. Tweed is in Hastings County, Ont.

Quebec, P.Q.—A contract has been made between the municipality and the Dorchester Electric Company by which the Dorchester Electric Company engaged to do the city

Barrett Specification Roofs



Warner Bros. Co., Corset Manufacturers, Bridgeport, Conn. Day & Zimmerman, Engineers, Philadelphia, Pa.

The Most Economical Roof

FOR half a century architects have known that slag and gravel roofs would *often* show marvelous durability.

The Barrett Specification defines the method by which these roofs may be built so that they will *always* show such durability.

It provides for the best materials manufactured, and prescribes the most approved methods of application.

A Barrett Specification Roof will cost less than any other permanent roof, will last upwards of twenty years and will need no painting or coating or care. Such roofs are fire-retardant and take the base rate of insurance.

That is why they are invariably used on large manufacturing plants where the roof areas are great and where, therefore, the unit costs are carefully studied.

Booklet giving the Barrett Specification in full mailed free on request. Address nearest office.

Special Note

We advise incorporating in plans the full wording of The Barrett Specification, in order to avoid any misunderstanding.

If an abbreviated form is desired however the following is suggested:

ROOFING—Shall be a Barrett Specification Roof laid as directed in printed Specification, revised August 15th, 1911, using the materials specified, and subject to the inspection requirement.

The Paterson Manufacturing Co., Limited

Montreal Toronto Winnipeg Vancouver St. John, N.B. Halifax, N.S.

lighting at seven cents per kilowatt hour. The contract with the Quebec Railway Light and Power Company expired on August 1 last, so that the new company will at once begin to put in their plant. Tenders will be called for in the near future.

Vancouver, B.C.—Gigantic power development is to be undertaken by the British Columbia Electric Railway Company during the present year. The plans are for the development during the present year of the generating station on the North Arm of Burrard Inlet, so as to make an available output from the plant of 85,500 horse-power. This practically means the doubling of the present output of this station. The plans at the Lake Buntzen plant and the North Arm station indicate that by the end of 1912 the company will probably have an available output of 105,000 horse-power. Plans are in hand for future developments of power sites controlled by the company which will bring its available output up to 200,000 horse-power.

SEWAGE AND WATER.

Aylmer, Que.—It is proposed to construct a septic tank to treat the sewage from the town before it is emptied into the Ottawa river. The estimated cost of the tank is $5,000 and the city of Ottawa has expressed its willingness to provide $2,500 towards the work. The town of Aylmer will supply the balance. Mr. Ker, City Engineer, Ottawa.

Brandon, Man.—Mayor Fleming in his opening address to the council stated that the waterworks system will be reorganized during the year 1912.

Halifax, N.S.—Since the installation of water meters, according to reports from the lakes, the large meters on the mains show that whereas a year ago the city consumption was about 2,250,000 gallons per day, now it is about 1,600,000 gallons per day. A very large saving.

Medicine Hat, Alta.—A scheme for building a reservoir in this city, with a capacity of 40,000,000 gallons, will be brought up before the city council in the near future. W. P. Morrison, Engineer.

Moose Jaw, Sask.—The water supply is holding out as well as may be expected for this time of the year. The Snowdy Springs and Ross Crescent supplies are still producing fairly well.

St. Catharines, Ont.—Recent examination of the drinking water showed infection to be absent.

Vancouver, B.C.—City Engineer Fellowes recommended that the four-foot brick and concrete sewer on Dufferin Street be extended from Yukon to Bridge, also the construction of a three-foot sewer on Bridge from Dufferin to Seventh Ave. The estimated cost of this work by day labor is $17,300

BUILDING.

Calgary, Alta.—Work will commence in the spring of 1912, on the grounds and buildings of the Calgary University. Rev. Dr. Braithwaite, of Toronto, has been appointed Dean.

Calgary, Alta.—The Rumley Machine Company of Laporte, Indiana, manufacturers of gas traction engines and other machinery, have purchased a site consisting of 25 acres of trackage property in this city. It is the intention of the company to establish a manufacturing plant on the property.

Listowel, Ont.—The Listowel agricultural society will spend $2,000 on erecting a new building on the fair grounds.

Montreal, P.Q.—The congregation of Westmount Methodist Church are contemplating the erection of a $120,000 structure. Rev. W. E. Baker, Pastor.

Port Arthur, Ont.—The city engineer's office have prepared preliminary plans for a fire station to cost about $25,000, also a telephone exchange building to cost about $24,000.

Port Stanley, Ont.—Speakers at the meeting of the London, Ont., board of trade suggested the necessity of the construction of a grain elevator at Port Stanley.

Saskatoon, Sask.—A company which will engage in the manufacture of Trojan flooring and fireproof partitions will erect a factory in this city. Mr. C. H. Forrester, of the International Construction Company, Winnipeg, Man., is interested in this project.

Toronto, Ont.—Work on the new St. Alban's Cathedral will commence in the spring. Messrs. Symons & Rae, local architects.

Vancouver, B.C.—Mr. J. D. Barton, New York, U.S.A., is contemplating the erection of an apartment house in this city to cost $250,000.

Winnipeg, Man. — The Canadian Consolidated Rubber Company and the Canadian Fairbanks Morse are about to erect large factories in the west end of the city.

ROADS AND PAVEMENTS.

Vancouver, B.C.—The city engineer, Mr. Fellowes, recommended to the council that tenders be called for the construction of a wood block pavement on Seymour Street from Robson to Pacific, and on Richards between the same two streets.

BUSINESS.

Bancroft, Ont.—$18,000 damage was caused by fire to several industries in this town. The buildings damaged included S. Plew's grist mill, D. Fuller's woollen mill, J. D. Payne's machine shop, and the electric light plant.

Province of British Columbia.—The British Columbia Fishery Company, of London, England, was recently organized with a capital of one million dollars for the exploitation of the deep sea fisheries of the Pacific coast off Queen Charlotte Islands. The company will engage in the salmon-fishing industry, and canning as well as in halibut, cod and herring fishing, and will establish canneries and plants for manufacturing by-products.

Montreal, P.Q.—A fire which broke out at the premises of Shearer, Brown & Wills Company, Ltd., lumber merchants, did damage to the extent of $80,000.

Trenton, Ont.—Fire damaged the opera house and a grain elevator owned by Mr. J. G. Squier. The machinery of the City Steam Laundry was also damaged. The estimated losses, $12,000.

Minitonas, Man.—J. D. Ramsay's general store was gutted by fire. More than $10,000 in stock was carried, and two-thirds of it was a total loss.

Victoria, B.C.—The estimates for the year for the fire department amount to $105,409, of which $68,716 is for salaries. The recommendation was made and adopted that twelve new alarm boxes and 4,000 feet of hose be purchased.

Yorkton, Sask.—The power plant and electric light system were seriously damaged by fire. A. C. Crasly, town engineer.

CURRENT NEWS.

Province of British Columbia.—The Forest Act brought down in the provincial legislature is an exceedingly comprehensive measure, comprising 144 sections. Among other measures it proposes to create what is to be known as the forest branch of the department of lands, to be presided over by a chief forester, with such assistance as he may require.

Calgary, Alta.—The present value of the equipment of the fire department is $291,670, made up of the following items: Equipment, $60,450, horses, harness, etc., $19,250; alarm system, $18,765; furniture, $2,600; buildings and land, $19,605.

Guelph, Ont.—A conference has been held between the municipal officials and the Canadian Pacific Railway, with a view of beautifying the railroad properties around the city.

Kingston, Ont.—That the city council purchase the Cataraqui bridge, and that the necessary by-law be prepared was the recommendation made by the civic finance committee.

Ottawa, Ont.—Representations have been made to the government for the appointment of a special commission to enquire into the lead-zinc industry. The lead bounty expires

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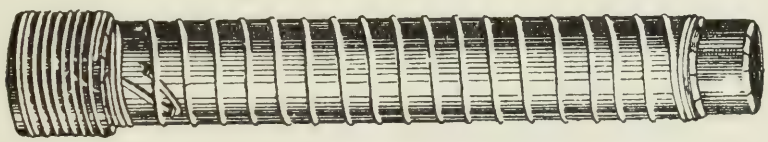

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in June and it is desired that in place of waiting for the tariff commission special enquiry be made meanwhile.

Province of Quebec.—Premier Gouin has opened negotiations with the government at Ottawa, looking to the acquisition of the territory known as Ungava, and its annexation to the Province of Quebec. The district is supposedly rich in minerals, fairly fertile, and adapted to colonization.

Toronto, Ont.—An estimate for the extension of Teraulay street has been prepared. The extension as proposed would be about three-fifths of a mile and would cross nine streets in the residential section. The cost is placed at $200,000.

Victoria, B.C.—$750,000 is the amount asked for by the council to carry on the civic business until the taxes are due.

Winnipeg, Calgary and Edmonton.—Notice comes from Ottawa that examinations will be held at Winnipeg, Calgary and Edmonton on February 12, 1912, of candidates for positions as Dominion land surveyors.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria street, London, S.W., during the week ending January 8th, 1912:—

A London firm desire to appoint agents at Montreal, Toronto, Winnipeg and other large centres in Canada, for the sale of a hygienic system of air purification suitable for theatres, picture halls, hospitals, schools, homes, etc.

A Yorkshire firm manufacturing druggists' sundries and surgical appliances, desire to get into touch with Canadian importers.

A London firm having a demand for best three-ply pine or similar three-ply wood, ask for names of Canadian manufacturers.

A West of England firm of dairy and agricultural engineers desire to get into communication with agents in Canada handling cheese-making appliances.

A firm in the West of England are in the market for supplies of tool handles of various kinds.

A London firm having a well-established connection amongst wholesale provision merchants, wish to get into correspondence with Canadian butter and cheese shippers requiring representation in Great Britain.

A correspondent in the province of Quebec is desirous of getting into touch with United Kingdom importers of Canadian hay.

A correspondent who is shortly returning to Canada is desirous of getting into touch with United Kingdom manufacturers requiring a resident agent in the Dominion; wishing to open a branch factory; open to see Canadian patent rights. Engineering, chemical or textile industries preferred.

The Canadian agent of an English manufacturer of condiments and essences is open to take up another line which he could work in conjunction.

A Montreal importer desires to obtain agencies for fancy goods.

A Winnipeg manufacturers' agent wishes to secure agencies for felt-shoe findings, house furnishings and builders' materials.

Inquiry is made by a Canadian correspondent now in Wales for the names of manufacturers of fancy leather goods requiring Canadian representation.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:

A German firm manufacturing pyrenees lambs-wool flannels (fleeces, ripples, naps, etc.), are seeking Canadian agents.

A Liverpool firm ask to be placed in touch with Canadian shippers of dried fish.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending January 15th, 1912:—

A London firm of small pipe organ manufacturers desire to open up business in Canada.

A London firm, stated to have a large market for Canadian rolled oats, wish to get into touch with some millers in the Dominion able to deal with large orders.

A London firm seek an agent in Canada for the sale of a street fire alarm system, and time-saving devices for fire stations.

A Scottish firm make inquiry for the names of Canadian buyers of Toe Calk steel.

A Yorkshire firm make inquiry for the names of Canadian miners of iron ore, who may be open to appoint an agent in Great Britain.

A Montreal chemist controlling a wholesale and several retail businesses in the city, is open to act as agent or manager of the Canadian branch of a first-class United Kingdom manufacturer. A London representative would call on interested parties.

A Montreal dealer in typewriter and duplicator supplies is open to correspond with United Kingdom manufacturers of these goods.

A Calgary correspondent, now in London, is open to take up agencies for heavy hardware, mine, mill and builders' supplies, iron and steel.

A Toronto correspondent would like to hear from United Kingdom importers of maple and birch logs in the round; also buyers of wood flour and excelsior; and buyers of maple and birch timber in the square.

A London correspondent who is shortly leaving for British Columbia, is desirous of securing agencies for the sale of paints, varnish, brushes, enamel baths, basins, sinks, galvanized cisterns, galvanized wire, nails, sheets, general ironmongery and house furnishings, stoves and boilers, wallpapers, glass, enamel tiles and other building materials.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:—

A London paper agent, who is about to visit Canada, and who claims an established connection among buyers of paper of various kinds, would be glad to get into touch with actual Canadian manufacturers of paper who are in a position to fill orders for export.

A London firm are open to purchase large quantities of cardboard milk bottle caps and invite quotations from Canadian manufacturers.

A Canadian company who are in the market for quantities of commercial sodium phosphate and ammonium chloride, invite quotations from manufacturers of these chemicals.

A manufacturers' agent in Montreal desires the addresses of manufacturers of orange-red mineral and of blanc fix for coating purposes on paper.

PATENTS.

The following is a list of patents granted to inventors in Canada. This list is furnished by Messrs. Fetherstonhaugh & Company, 10 King Street East, Toronto:—

F. J. Alderson and W. H. Dunsmore, shocking machines; C. M. Conklin, students' chair; W. Nepean-Hutchison, lock washers; A. Lemieux, price tags; G. W. Mallory, animal bits; H. L. Mason, trousers; W. C. Weeks, gravel washers.

The following is a list of Canadian patents recently issued through the agency of Messrs. Ridout & Maybee, Manning Chambers, Toronto:—

Sir C. C. Wakefield, force feed lubricator; C. H. Sivel, safety apparatus for mining cages, lifts and the like; Wilhelm Gunther, process of treating ores; W. U. Jackson, H. Lloyd, and S. F. Murrell, tube making machinery; Friedrich Stamuschulte, recuperator; E. H. Nutter and H. Lavers, ore concentration (fractional flotation); C. V. Thierry, metallurgy of zinc; Emil Fleischer, process and apparatus for making steel; L. Sunderland, and G. C. Pillinger, electrical control of engines, dynamos and batteries; A. E. Tilburn, fountain brush; G. H. Robinson, packing for piston rods or the like; Samuel Aikins (re-issue), door knobs; J. H. Garbutt and W. J. Kemmis, seed covering attachment for drils; H. Brune and H. Horst, process of drying raw peat; W. H. Baxter, stone washing machinery; R. C. Quin, fenders for rolling stock; C. B. Redrup, fluid pressure engines or pumps.

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Goodyear Sheet Packing for High or Low Pressure
Magnet High-Pressure Gasket Tubing

After months of painstaking experiment we have perfected Sheet Packing and high-pressure *Gasket Tubing* that forever *do away* with the disappointment, trouble and expense caused consumers by the many cheap and worthless grades that have been placed on the market.

Magnet Sheet Packing

Made of the celebrated Magnet compound, this packing is totally *unaffected by heat, oil, liquor (ammonia), alkali, or by expansion or contraction.*

It is suitable for high or low pressure uses, particularly high, because of its heat-resisting properties. It neither becomes hard nor brittle. Retains its tough, elastic efficiency for months.

Magnet Sheet Packing won't *blow out.* It makes a tight joint that stays tight under air, hot or cold water or strain pressure.

Meets every requirement.

No engine room, locomotive, steamboat or machine shop is properly equipped without a roll of this great emergency packing.

GOODYEAR

Magnet High-Pressure Gasket Tubing

Made also from the celebrated Magnet compound. Forms a tight joint no matter how rough the surface may be—and it is

Pressure-Proof

Magnet Gasket Tubing can't blow out. Like Magnet Sheeting, it successfully resists any degree of steam heat and it maintains its elasticity.

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One of the big advantages of Magnet Gasket Tubing is that it may be cut any length to fit any size manhole or handhole, plate or pipe flange. Cut ends joined together with rubber core, making *continuous gasket.* Put up in convenient boxes with rubber core and tape.

If you need sheet packing or gasket tubing, grasp this opportunity. The Goodyear trade-mark stands for reduced first cost and economy all along the line. It stands for the same quality workmanship that underlies the success of the Goodyear Tire & Rubber Company, Akron, Ohio, one of the best known and most experienced manufacturers of rubber goods in the world. In all of our business in Canada last year, we had to replace, because of slight defects, only $155.22 worth of goods.

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MEETINGS.

At an address given before the Engineers' Society of the University of Manitoba, Hon. R. P. Roblin, honorary president, remarked that engineering is as old as history. We have records of magnificent engineering feats from the hanging walls of Babylon and the reclamation of the desert by the Pharaohs down to the present day. While the Province of Manitoba is at present handicapped from providing adequate facilities for education and instruction in your profession still you can now get the principles here as well as at any other university on the continent. A man may be graduated with honors but still be an absolute failure. The foundations necessary to a man are character and reputation. Have character as the keystone of your life's work. The opportunities in the west are many. Electricity is one of the greatest adjuncts of civilization, and its possibilities are illimitable, in which connection might be mentioned the great asset of water power which we have. There is a rich and fertile field before you.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

15788—January 12—Authorizing C.N.R. to open for carriage of traffic its line from Groose Isle, Man., to end of track, 31 miles, fencing, etc., to be completed by August 1, 1912.

15789—January 12—Authorizing G.T.R. to reconstruct bridge No. 39 at mileage 216.51, 18th District, over Pike's Creek, Ont.

15790—January 4—Authorizing C.N.O. Ry. to take property of Joanna Britnell, in City of Belleville, Ont., for diverting Bay Street.

15791—January 10—Authorizing C.P.R. to reconstruct bridge No. 43.8 on Farnham Subdivision, Montreal Terminals.

15792—January 13—Authorizing Government of British Columbia to construct highway crossing over track of Columbia & Western Ry. at Eholt, B.C.

15793—January 13—Authorizing C.P.R. to operate and construct spur for Standard Fish & Fertilizer Co., Calgary, Alta.

15794—January 11—Authorizing C.P.R. to construct its Kerrobert Northeasterly Branch across highways from mileage 1.52 to 19.16, Saskatchewan.

15795—January 12—Authorizing C.N.R. to use for construction purposes only until July 1, 1912, crossing with its Deslisle Extension of track of C.P.R. Moose Jaw-Lacombe Branch.

15796—January 11—Authorizing C.N.R. to construct spur into plant of Saskatoon Milling & Elevating Co., Saskatoon, Sask.

15797-98-99—January 15—Authorizing C.N.O. Ry. (Sudbury-Port Arthur Line and Montreal-Port Arthur Line) and approving locations through unsurveyed territory, District of Algoma, mileage 327 to 343.15 from Sudbury Jct., through Twps. of Nepean, March and Torbolton, County of Carleton, Ont., mileage 14.3 to 27 from Ottawa, and through Twps. of Ross, Westmeath and Pembroke, County Renfrew, Ont., mileage 67 to 83.45 from Ottawa.

15800—January 12—Authorizing City of Toronto to maintain wires across C.P.R. and G.T.R. and C.P.R. Tel. Co., also G.N.W. Tel. Co., at Queen Street, Toronto, Ont. Rescinding Order 13817, May 31, 1911.

15801—January 11—On Mond Nickel Co., Ltd., application authorizing C.P.R. to construct a public crossing at mileage 70.06 of its Cartier Subdivision, Ontario.

15802—January 11—Authorizing Canadian Copper Co. to construct spur across Algoma Eastern Ry. at grade and C.P.R. by overhead crossing, interlocking semaphores to be installed.

15803—January 15—Relieving C.P.R. from erecting and maintaining fences, cattle guards on Atlantic Division, between Woodstock and Andover, N.B.

15804—January 15—15805—January 16—Issuing certificate of correction to G.T.P.B.L. Co. correcting errors in locations of Biggar-Calgary Branch and Regina-Moosejaw Branch.

15806—December 21—Directing that G.T.R. install improved type of electric bell at Edward Street, Prescott, Ont., 20 per cent. from Railway Grade Crossing Fund.

15807—November 27—Authorizing C.N.O. Ry. to join with its line the tracks of Montreal Terminal Railway and C.N.Q. Ry. near Montreal, Que.

15808—November 17—Striking out words "at Vickers Street" in Order 15655 of December 20, 1911, City of Fort William and C.N.R. crossing.

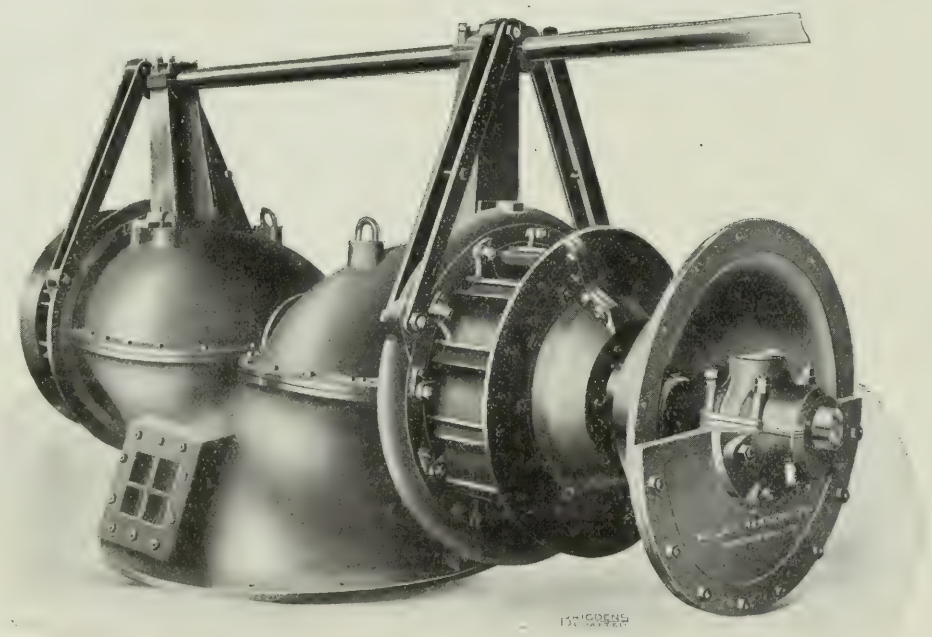
15809—January 17—Authorizing C.N.R. Ry. to construct spur in town of Neepawa, Man.

15810—January 4—Dismissing application of Sanitaris, Ltd., of Arnprior, Ont., re express classification on returned empties.

15811—January 9—Authorizing C.P.R. to take certain lands in City of Toronto, and construct branch line to cross G.T.R. and join tracks used in common with G.T.R., also to cross Toronto Railway at Junction of Spadina Avenue and Front Street.

15812—January 18—Authorizing C.P.R. (Credit Valley Ry.) to construct spur into premises of Stone Fertilizer Co., Twp. of North Oxford, County of Oxford, Ont.

15813—January 16—15814—January 18—Approving plans of drain known as "A. Gilbert Drain" along right of way of M.C. Ry. to be constructed by Twp. of Southwold, Ont.; also plans and character of Chauvin Drain, under G.T.R. in Twp. of Tilbury North, Ont.



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Volume 22. Toronto, February 8, 1912

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The Canadian Engineer

An Engineering Weekly

THE DESTRUCTION OF HOUSE REFUSE BY INCINERATION.

By RAY R. KNIGHT, A.M., Can. Soc. C.E., Etc.

The question of the sanitary disposition of house refuse is one which is exercising the minds of those in civic control of the large cities throughout this country at the present time, and it is a problem which demands the closest attention and most active administration in order to lessen the rate of typhoid and other diseases.

The common house refuse dump is the germinating centre of the house fly, and the house fly is the most serious carrier of the germs of diseases such as typhoid, tuberculosis, infantile diarrhoea, etc.

To quote from a circular recently issued by the Department of Agriculture, Canada:

"House flies breed in such decaying and fermenting matter as kitchen refuse and garbage. . . . All such refuse should be burned or buried within a few days, but at once if possible. . . ."

The burying of refuse is a proposition which cannot be entertained by the larger cities, as large areas of ground would be necessary for this purpose, so that the city has to prepare for burning its refuse.

To effect this the incinerator or refuse destructor is requisitioned.

Before getting into the subject real of this article it will be necessary to define the term house refuse and to subdivide it so as to agree with the general practice in Canada.

The term "house refuse" is an "old country" one, including as it does the whole of the refuse from an inhabited dwelling, excepting faecal matter.

Strictly speaking such items as slaughter house offal, dead animals, street sweepings, trade refuse, and industrial wastes are not included.

In Canada, where American terms have become general, these matters are divided under three heads, viz.: Garbage, rubbish and ashes. These are generally held to include the following:

"Garbage" includes all refuse of an organic nature, consisting of food wastes or swill.

"Rubbish" includes all combustible matter, such as paper, wood, rags, leather and house sweepings, also glass, iron, crockery, and such like.

"Ashes" includes household fire, kitchen fire, and heating furnace ashes. (Factory, industrial or boiler ashes are not included.)

Items not included are faecal matter, slaughter house offal, dead animals, street sweepings, and sewage sludge.

The matters which come under the head of "garbage" are those which give rise to insanitary conditions. Rubbish and ashes do not offend in this respect, so that the question before the engineer is really the disposal of "garbage" by incineration. The first question to decide in the formation of a scheme for house refuse disposal is that of subdivision of the matter. Garbage has to be burnt, rubbish may either be burnt or dumped, and ashes may be required to assist in the combustion of the garbage or may be entirely dumped. Probably the best method to adopt is to burn all garbage and rubbish, and dump all ashes excepting a certain amount required for assistance in combustion. Such a plan would require the division of the receptacles at the house into two compartments, one for garbage and rubbish, the other for ashes.

The matter of division, however, becomes somewhat altered where power is to be developed at the incinerator plant, as in this instance it is essential to have the ashes incorporated with the garbage and rubbish. Whether the whole or only part of the ashes are required to produce high temperatures is a question which has no general solution, but which must be decided upon investigation. The fine ash dust is however of very little value as a fuel, so that it would be necessary to screen the ashes and use only the larger.

The incinerator plant which will be discussed in this article will include the boiler and its appurtenances for the production of power.

Having arrived at some conclusion (as definite as can be with regard to the changeable characteristics of the material to be dealt with) as to the necessary subdivision, the question of quantity has to be decided.

Canadian households produce far more house refuse than those in the "old country." This is probably due to the absence of open fires which would receive and destroy a good amount of waste and also to the fact that thrift is less practical here. Be the cause what it may, the quantities given in data furnished by English cities are of no use to the engineer designing a plant in Canada.

An instance of this may be cited. In England a town of 36,000 people produces about 66 to 75 cubic yards of refuse (garbage, rubbish and ashes) per day, whereas in Westmount, Que., the population is 18,000 (half the population) and the production is between 80 and 103 cubic yards per day. An average for the large American cities is 57.7 cubic yards per day for a population of 18,000. These comparisons are given not so much as guides for the engineer but to warn him that it is essential to ascertain the amount of refuse the town or city produces actually.

In spite of the fact that quantities of house refuse vary considerably as between different towns or cities, the general composition remains reasonably constant, so that data as to the calorific value can be applied (within certain limits) to the design of furnaces and boilers for generating certain powers.

It will be noticed that quantities of house refuse are given in cubic yards in this article. This is not general, but would seem to be the better method of measuring owing to the excessive variations in weight. It will be necessary, however, to reduce cubic yards to tons when the amount of power that can be generated has to be ascertained. For this purpose the following weights have been taken:

	Lbs. per cub. yd.
Garbage	1,250
Ashes	1,500
Rubbish	300

Refuse composed of 14 per cent. garbage; 56 per cent. of ashes, and 30 per cent. of rubbish by volume is assumed to weigh 1,100 lbs. per cubic yard.

The calorific value of house refuse, garbage, ashes and rubbish, is of course a variable quantity, but it is usually considered for estimating purposes that 1 lb. of refuse will evaporate one pound of water from and at 212 deg. F. One pound of good steam coal will evaporate 8 to 10 lbs. of water from and at 212 deg. F. The dominating principle, however, in the design of an incinerator plant is the complete destruction of everything, solid and gaseous, and not the production of power, and to do this a temperature of at least 1,250 deg. F. must be constantly maintained, as at this temperature it has been ascertained that gases are rendered innocuous. Higher temperatures, however, should be aimed at, and a temperature of at least 2,000 deg. F. should be maintained in the combustion flue. This, of course, has to be accomplished with the aid of forced draught. For many years the steam jet was used in connection with refuse destructor furnaces, air being forced by the steam through the fire bars, water gas effect being produced and two highly combustible gases evolved, viz., hydrogen and carbon monoxide. These gases assisted in raising the temperature. The air was admitted without being heated, which was a serious drawback when moist or wet refuse had to be dealt with.

It is the general practice now to use hot air blasts in destructor furnaces, the necessary power being provided either by positive blowers or fans. Steam in just sufficient quantity to preserve the fire bars should be used in the forced draught.

We have, therefore, in the design of an incinerator plant to burn the matters collected and dumped at the works, produce a high temperature so as to render all gases innocuous, and provide as much power as is consistent with good results from the aesthetic and health standpoint.

In order to accomplish this the following principles have to be incorporated:

Storage of Refuse at the Incinerator.—In view of providing power for electric lighting, or for heating buildings, it is necessary in order to produce power when it is required to store some part of the day's collection of refuse upon the premises.

Storage should be made in closed receptacles. One form which has been tried in England provides for the storage of refuse in "tubs," which are stored in tiers and conveyed by overhead gear to the furnaces when required, the tubs being sealed with lids to prevent the escape of noxious gases.

The usual method, however, for storage of refuse is in a wrought iron or steel hopper. In order to prevent gases, due to decomposition, escaping, and to prevent the access of flies to the contents of the hoppers, they should be covered with hinged lids, and I would go as far as to recommend that these lids be water-sealed.

Method of Introducing Refuse into the Furnace.—The hoppers for storing refuse are best located above the furnace in such a position that the contents can be raked into a "feeding hole" in the furnaces with the least possible trouble, and as expeditiously as possible, as the length of time the furnace remains open governs the temperature of the whole plant to a large extent. The longer cold air has means of access via the "feeding hole" the cooler will become that particular furnace, and being connected with others the cooling effect will be noticed there also.

Where power is not required and a "direct feed" type of furnace used the refuse is dumped directly from the cart into the furnace.

In either case the feeding hole should be provided with a water-sealed door, in order to prevent the escape of fumes from the furnace while burning is going on. The water seal troughs in connection with the doors are kept at a constant level by a ball cock feed cistern, so that water evaporated by the heat of the furnace is replaced. While feeding or tipping refuse is proceeding it is necessary to introduce a hopper to prevent matters lodging in the trough.

Drying Hearth.—Immediately below the "feeding hole" should be located the drying hearth, upon which the refuse which is to form the next charge should remain whilst the charge is burning on the grate. Refuse contains varying quantities of moisture. Garbage contains from 60 per cent. to 80 per cent. of water. The percentage amount of water in mixed garbage, ashes and rubbish will of course depend largely upon the amount of ashes and rubbish contained. In the green vegetable season when the proportion of ash is low, the amount of moisture would reach the higher figure, while in the winter probably the lower figure would represent the percentage.

It is impossible to entirely remove this moisture on the drying hearth by the general heat of the furnace, and that reflected by the reverberatory arch, in fact only a very small amount of moisture is removed in this way. In drying refuse, gases and offensive fumes are given off, so that it is essential that the furnace be so constructed that these gases and fumes are compelled to pass over the hottest part of the fires before they can gain access to the flues.

Grate.—General practice seems to favor a sloping grate, and I have no hesitation in saying that I consider a sloping grate far in advance of the horizontal type for incinerator furnaces. The slope assists pulling down the refuse from the drying hearth and also facilitates to a very large extent the "clinkering" operation.

The essential features in the design of the fire bars are the retention of as much of the fine particles of refuse as possible and the admission of the proper amount of blast equally distributed throughout the grate area.

The type of grate bar most favored is that in which cylindrical holes are formed at the surface with conical holes at the under side. This type of bar proves very efficient for incinerator furnaces.

The front of the grate is formed by a cast iron dead plate which is placed horizontally and forms a continuous grate to the clinkering door in the front of the furnace. This plate being "dead" the actual flame does not impinge upon the front clinkering door to such an extent as if the perforated bars were continued through to the front.

Ashpit and Blast Chamber.—Below the furnace is provided an ashpit which also forms the blast chamber. The ashpit should be hermetically sealed and a pressure of 1 inch to 1½ inches of water should be maintained while burning. The

hot air conduit and steam jets are arranged to discharge at the will of the operator into this pit. The mixture of steam and hot air that serves the best purpose in burning can be ascertained.

Clinkering and Pulling Down Doors.—The operation known as "clinkering" is that of clearing the furnace of a burnt charge. As soon as the whole charge is considered thoroughly burned through, it should be drawn out, and this is done in the following manner: The blast is shut off from the particular furnace to be clinkered, and the clinkering door is elevated. The firemen with slices, pokers and rakes with long handles pull out the burnt charge in the form of clinker into barrows or tip wagons, leaving only odds and ends of incandescent or red hot pieces on the grate. The clinkering door is then lowered, and the charge from the drying hearth pulled down upon the grate through the pulling down door with long handled rake. As soon as the new charge is evenly spread about, three or four inches thick, the blast is turned on and more refuse pulled down as the fire increases in brightness until the limit (about six or seven inches of clinker' is reached, when the furnace is clinkered again.

It is essential in the operators of an incinerator plant to "charge" and "clinker" the furnaces in a regular cycle, so that the hot gases from advanced fires assist in the combustion of the gases given off from a new charge burning up.

Reverberatory Arch.—The furnace is covered by a fire-brick arch which plays a similar part to the reverberatory arch in other furnaces. This arch can be kept at a very high temperature throughout with care and expeditious handling, and the less it is cooled in process of feeding and clinkering the quicker will the fire rekindle.

Type of Furnace.—The foregoing particulars have reference only to the unit furnace, which is capable of destroying 12 to 20 cubic yards per working day of 12 hours with a grate area of about 30 square feet. In order to burn the refuse of a town or city provision has to be made for a set of furnaces. The continuous furnace as separate from the separate "cell" type has proved itself far more economical in first cost and repairs, and is the type I would recommend. By a continuous furnace type is meant the arrangement of furnace units side by side with an opening at the side connecting one with the other, so that the gases from furnace No. 1 are discharged into furnace No. 2, and these form 1 and 2 combined into No. 3, and so on. Four furnaces connected in this manner would constitute the limit, and I am of opinion that three furnaces only should be so connected. By this means the heated gases of advanced fires will materially assist fires in a less advanced stage, if proper regard is had to a cycle of operation. In the "cell" type each cell has its own flue.

Combustion Chamber.—The gases from the furnaces are discharged into a combustion chamber. This chamber has no particular shape or design, but is simply a large enclosed flue where the gases intermingle and carry on further incineration which the furnaces have left incomplete. The temperature maintained in the combustion chamber is the index of efficient burning. There should never be a less temperature than 1,500 deg. F. in this chamber, and much better results will be obtained if the temperature is kept at 1,800 to 2,000 deg. F. In the winter such a temperature is easily maintained, but in the summer it is probably only the lower temperature that can be raised. The combustion chamber also acts as a dust pocket, and mattress, slaughter house offal and dead animal, burning chamber. A large door is provided, preferably at the top for the purpose of admitting these larger articles. A door about 3 ft. 9 ins. by 3 ft. is usually found large enough to take a horse. Two outlets from this chamber are provided, the one leading to the boiler, the other to the by-pass flue. Each of these outlets should be provided with a damper to regulate the direction of the hot gases.

Boiler.—A water tube boiler with the ordinary setting and with a bridge and baffles so arranged as to direct the gases through the spaces between the tubes is usually provided in connection with incinerator plants. It is essential that a grate be provided under the boiler so that steam can be raised by a coal fire to start up the works after shutting down or after Sundays or where the power is entirely depended upon, as a stand-by. Description of the boiler and its setting is superfluous here. Superheaters and economizers may be added.

Air Regenerator.—The gases after passing through the boiler are led to the air heater. The gases if by-passed also lead to this apparatus. In the regenerator which is usually a cast-iron or steam tube arrangement of pipes so arranged as to expose the maximum amount of surface to the gases, the air for working the blasts is heated. The air is drawn from the upper parts of the building so as to take any escaped fumes or smoke, by a fan or positive blower and discharged into the regenerator and led to a concrete conduit below the furnaces. Each furnace is provided with a valve for admission of the blast. The air should be heated to from 500° to 600° Fah.

Main Flue.—After leaving the regenerator the gases are discharged into the main flue which carries them to the base of the stack.

In the main flue a dust pocket should be introduced. A right angle turn at the base of the stack with an extended flue, the floor of which is depressed about 3 feet, will answer this purpose. A door should be fitted to this pocket, for the periodical removal of dust.

Stack or Tall Chimney.—The usual remarks for furnace chimneys apply here. A stack from 60 to 100 feet high lined with fire-brick up to 60 feet is sufficient. The height of the chimney largely depends upon the aesthetic side of the question. With a good quality of garbage and a well handled plant and not too much cooling of gases for power production, a 60 ft. shaft is sufficient, but having regard to the occasional lack of care and other matters, I would suggest 100 feet as the height. A damper should be provided at the base of the stack, and for test purposes a piece of wrought iron tube should be left in, connecting with the inside of the stack.

Flues Generally.—In all flues provision must be made for expansion and contraction of the firebrick linings. Test or "peep" holes should be built into the flues at intervals for observations.

Firebrick Work.—The furnaces should be constructed of firebrick throughout. The best quality of firebrick should be used, as the varying temperatures are a severe test. Poor quality bricks will crack and fall out. Arches should be formed with radiated bricks, the taper being formed in the length of the brick. Fine ground fireclay should be used for mortar with the addition of sodium silicate in proportion of 1 to 20 by volume. The addition of fine powdered glass in proportion of three of fireclay to one of glass by volume has proved very successful in furnace building. The glass forms a flux at high temperatures and attaches itself to the bricks. The life of furnace brickwork is extended materially in this way.

The combustion flue should have a lining of best quality firebrick 9 inches thick. The boiler and all flues should be lined with firebrick (not necessarily best quality) 4½ inches

thick. The firebrick linings must not be bonded with the ordinary brickwork.

Opinion is divided as to the utility of the air space between the firebrick lining and the outside brickwork. Cheaper and better work and a more stable result after working can be obtained without the cavity, and the loss of heat being so small as to be almost negligible it would appear that the cavity could be left out. I consider work with cavities and wire bonding with 9 inch firebrick work (which is essential) costs 25 per cent. more than ordinary work, with the lining built against the outside work.

Buck stays and ties must be used to hold the furnaces and combustion chamber together. The whole should be free to "breathe" and it is essential to keep the boiler setting free from the effect of movements of other parts of the plant or strains may be set up, and injury to the tubes brought about. The whole plant should be free to expand or "breathe" as it is called.

The Cost of Incinerator Plants, and Working.—For the purpose of preparing an estimate for the erection of a destructor plant the following figures may be useful as a guide. Care should be taken however to add for local conditions and diifficulties. The prices are considered at Toronto, Ontario.

1. Two grate furnace plant with flues, hopper storage, boiler, regenerator, and chimney, capable of burning 80 cubic yards of refuse (garbage, ashes and rubbish) per day of 24 hours with 100 horse power boiler with steam fitting, $17,500.

1. Three grate ditto to burn 120 cubic yards with 150 horse power boiler, $23,500.

1. Six grate ditto to burn 240 cubic yards with two 150 horse power boilers, $39,000.

In addition to the above, prices for land, buildings, drainage, water supply, engines, dynamos, etc., auxiliary coal fed boilers, approach roads, and elevator for horse and cart where levels require it must be included.

The building should provide space for the plant which in the case of a two grate plant would be about 19′ × 24′ × 30′ to eaves; three grate plant about, 25′ × 24′ × 30′ to eaves; six grate plant about, 80′ × 24′ × 30′ to eaves. There should in this building be a tipping platform, and a feeding platform. In addition a boiler house, an engine and generator house with appurtenances must be provided, also engine and fan room, bathroom, W.C. lavatory, urinal, office, store and mess room.

The total site for buildings and future extensions and clinker storage should be about 1 to 1½ acres.

The staff necessary for operating an incinerator plant apart from the generating station and auxiliary boilers for 24 hours in eight hour shifts is as follows:

Number of furnace units.	Superintendent.	Laborers on feeding platform.	Firemen clinkering fires.	Laborers removing clinker.	Laborers Cleaning and assisting in removing clinker.	Engineer for fan and engine and boiler (assisted by engineers in generating station).	Ant. of refuse burnt. Total per 24 hours.
2	1	2	2	1	1	1	80
3	1	2	3	1	1	1	120
6	1	4	6	2	2	1	240

This staff is based on the assumption that the greatest load on the plant is during eight hours from 5 p.m. to 1 a.m. and that during the remainder of the day the plant is running light. The costs of flue cleaning once a fortnight and boiler cleaning as often as is necessary, have to be added. Interest on capital, depreciation and repairs have to be included in the costs. I consider in good class work the furnaces will require renewal once in 4 years and the combustion flue once in 8 years. Odds and ends of patching will be required in the meantime. The location of an incinerator is a point which has to be left to the discretion of the engineer to do what is best under the circumstances. It may be well to point out though that a modern refuse destructor properly managed is free from any nuisance from the health standpoint. The aesthetic nuisance however has to be overcome and though a site may be good from its position, being central it is probably better to locate the works in a neighborhood where from its character the plant would not be objected to. The cost of land is also a prohibitive feature sometimes.

In a large city it will be found economical to divide the city area into subdivisions of about 3 mile radius and provide an incinerator for each area.

The cost of burning refuse without deducting for fuel saved at generating stations and including interest and principal on 30-year debentures will vary between 30 cents and 40 cents per yard cube.

CRACKED CONCRETE CHIMNEYS.

In a report dealing with the cracked concrete stack of an English manufacturing plant, Sanford E. Thompson discusses conditions and some possible remedies which are of interest to those manufacturers who are burdened with big stacks built on the unhappy principle of a dry-mixed concrete. In this particular case of the London chimney, the structure had been put up on the dry-mix plan that was in vogue some years ago. The lower third of the stack was of greater diameter than the upper portion, and in the region of the offset, and above it, there were many long vertical cracks. The internal temperature of the stack was pretty evenly maintained throughout the year by the usual operation of the power plant, and there was some leakage through the cracks from the outside. The main concern of the owners, however, was as to the stability of the stack.

Danger from shearing stresses was considered very remote, since such stresses would not reach a critical point until long vertical cracks had formed on opposite sides of the chimney; and even then, an adequate amount of horizontal reinforcement would prevent the disruption of the stack. Corrosion and consequent weakening of the reinforcing steel was considered the point of most danger, the probability of this being rather large in case of concrete mixed so dry that it did not make a perfect bond with the reinforcement. With wet-mixed concrete the reinforcing steel is usually covered with a film of cement which will for a long time prevent corrosion of the steel by gases and moisture making their way in through the cracks.

As to remedies, the placing of a fire-brick lining was considered undesirable; such a lining would protect the concrete of the stack to some extent against the heat, but as good concrete easily resists a steady temperature of 600 or 700 deg. F., there was no need of a lining on this score. Moreover, it was considered that the presence of the lining might be mischievous, through the new expansion strains which it might transmit to the concrete strucure.

Repair by placing a shell of new concrete on the outside of the stack was considered the best course to follow. It is possible in building such a reinforcing shell, to shut off all access of atmospheric gases and moisture to the reinforcing members of the original structure, and to use reinforcing steel in such a way as to make good the weaknesses that have developed in the original structure owing to cracks, or to a presumption of an insufficient bonding of the reinforcement due to too dry a mix.

REPORT OF ANNUAL MEETING OF CANADIAN SOCIETY OF CIVIL ENGINEERS.

(Continued from last week.)

Friday Morning's Session—January 26th, 1912. PRESIDENT C. H. RUST in the chair.

MR. TYE: It seems to me we are giving everybody an opportunity of discussing these reports. We are referring these reports back to the different branches for discussion, including this branch here, so that every member will have an opportunity of discussing it. The point is that you cannot discuss them here to-day. So we are giving you all a chance in this amendment of Mr. Duggan's to discuss them to your heart's desire—the Good Roads report and every other report.

MR. MARCEAU: I quite agree with Mr. Tye that these reports should be referred to the different branches for discussion and suggestions.

DR. GALBRAITH: Unfortunately for myself I did not hear Mr. Duggan's amendment very well. How is the vote on these reports to be decided?

MR. JOHN KENNEDY: While the action we have taken as regards these reports is a very good one in every respect, I have not a word to say about it, but what shall we do about the Senate matter? It has been before the Senate for some considerable time and can we do anything towards getting the bill held over or something of that sort, because the bill is very much the contrary of what I fancy the majority of engineers think to be practicable. Can we do anything in the matter? Can our council take any hand in the matter and ask that it should be held over? I am sorry I have not a proposition to make, but the case is a rather serious one, and something really ought to be done.

THE PRESIDENT: I quite agree with you, Mr. Kennedy, that it is a very drastic method, but some engineers, I believe, are rather in favor of it. I appeared personally before the Senate some two years ago, at their request, and I pointed out my opinion in connection with the matter, and I also called the attention of the City of Toronto Council to it, but they have not taken any action. In fact, a good many of the outside public generally, I think, approve of Senator Belcourt's resolution, but if the society of the whole should pass a resolution suggesting that the matter be postponed until we have had an opportunity of taking it up with the committee, it might probably be a good thing if we can do it. Mr. Chipman has been taking some interest in this matter and I would like to hear his views on it.

MR. CHIPMAN: I have read with great interest the report of the committee as they appeared in the transactions. I regret to say, however, that there are some inaccuracies in it which should not have gone to the public. With reference to the streams in the west, there was a remark made that typhoid fever was caused by the floods in the streams. Now, we all know, who have lived in that country, that typhoid fever is epidemic in many towns distant from those streams, and in those towns cited the typhoid epidemic was in sections of the city that were not served with the water supplied from the river at all.

With respect to the pollution of Lake Ontario, there is a contradictory report in that statement that Lake Ontario water is the purest on the face of the earth, and there is another statement to the effect that it is badly polluted. I don't think a report like that does any great credit to the society. Remarks of that kind, I think, should have been edited in some way by the committee before they were presented.

With respect to the city of Guelph, it is true that the city of Guelph was in trouble respecting its sewage disposal, but the facts were not all stated. The works were not properly conducted as all municipal works are at times, through the economy of the municipal council, the cause of the nuisance was due to another source altogether from the muncipality. Now, there is a greater nuisance there to-day —ten times greater from a brewery than there is from the sewage disposal works. The sewage disposal works are quite up-to-date at the present time—even enlargements have been made.

With respect to this report I think we should receive it but not adopt it, as was done last year. The chairman of the committee is not here. Mr. Kennedy and I are the only two of the committee who are present. I think we should be permitted to report again next year.

THE PRESIDENT: I want to get your ideas as to whether this meeting should take any action in regard to Senator Belcourt's bill. That is what I was referring to, which prohitits the discharge of sewage of all kinds into any body of fresh water. Mr. Kennedy suggested that the society should take some action in the matter.

MR. CHIPMAN: I don't think at the present stage we should take any action in a matter of this kind. We are all studying these problems, and I do not think there would be anything gained by taking any action in the matter at the present time.

MR. TYE: I think it would be well for the society to take some action in the matter. I think it would be well if we appointed a committee to deal with the subject, if it is necessary to appear before the Senate and guide their legislation and help them. I think that the Senate would be quite willing and in fact glad to have the services of a committee from this society. This committee should be composed of men like Mr. Chipman, who are authorities on the subject, and who could help the Senate, and I think it is part of our duty to help guide legislation on such an important subject. Our committee composed of the proper men would certainly know more about it than the members of the Senate, and I beg to move that a committee be appointed to consist of Mr. Chipman, Mr. Kennedy and Mr. Lea, to deal with this subject before the Senate, and that their expenses be paid by the society.

MR. ST. GEORGE: You would not wish the society to get the Senate to withdraw the bill for the present. You see, they have had it so many years before them now. If the society do anything to hamper them in passing legislation, they might give time to these different smaller municipalities, but it might not be advisable to stop the bill. The committee might give advice to the Senate with reference to giving certain municipalities the necessary guidance.

MR. LEOFRED: You must not forget that the Provincial Governments are now spending much money and they are appointing officers every year with a special view of studying the question and obtaining legislation which would be adopted both by the Proincial and Dominion Governments. So I think it is scarcely wise for this society to interfere in the matter. The very best medical authorities in the country are working on the matter now, and are paid by the Provincial and Dominion Governments to study the

question, and I think we are not quite in our place to go before the Senate and interfere at this moment. We are not supposed to be such great authorities in sanitary matters, and in the analysis of bacteria as connected with the pollution of rivers and streams. I do not think we have the necessary knowledge in that matter to speak before the Senate, when there are so many eminent medical men, and chemists studying the question, to improve the situation. I do not see, for my part, what the civil engineers would have to gain by adopting such legislation as would prevent cities and towns from making an outlet for their sewage system into any river. There is still a great deal of controversy on the matter, and just now the cities and towns have not got the means to exactly satisfy the provisions of this bill.

MR. ST. GEORGE: I have great pleasure in seconding Mr. Tye's motion in regard to this committee. I feel confident that the society can leave it in the hands of the men named.

MR. JAMIESON: I thoroughy agree with Mr. Tye's motion, and that it is in the right line, namely, to put this committee at the disposal of the Senate to give them advice in the matter.

MR. KEEFER: I think, Mr. President, that it is a very excellent suggestion of Mr. Tye's to have an advisory committee, and that this society should show its willingness to co-operate with the government and assist them to prevent the pollution of our rivers and streams, because, of course, that is a very serious and important matter. The only question is the manner of doing it.

THE PRESIDENT: You have heard the resolution. What is your pleasure, gentlemen?

MR. JOHN KENNEDY: It seems to me the committee is a little small.

THE PRESIDENT: I would suggest that Mr. Tye be added to that committee.

MR. CHIPMAN: I wish to put myself right before the society, before this resolution is passed. I do not wish you to understand that I oppose or was not in sympathy with Senator Belcourt's bill, but simply that I did not think we should pass any resolution advocating the passing of that bill at the present time. I am quite in sympathy in assisting him in every way, and I think there are no men in the Dominion better qualified or in a better position to assist the government than we are.

MR. TYE: I did not mean by my resolution that we should appoint this committee and bind its hands, but I meant to leave it entirely in their hands to do entirely as they thought best under the circumstances as they find them.

THE PRESIDENT: Is it your pleasure that this motion should carry?

Carried.

THE PRESIDENT: There is a letter here from Mr. Forrester. Mr. Forrester sends a letter on steel pipes.

THE SECRETARY: I wrote to Mr. Forrester and suggested that he appear at the annual meeting, and he said he could not do so.

(The letter is referred to the incoming council.)

THE SECRETARY: I have here a letter from Mr. McIntyre.

THE SECRETARY: I have a letter here from Mr. P. M. Sauder, who writes to submit a resolution.

MR. JOHN KENNEDY: It seems to me this should be referred to the Conservation Committee.

MR. MITCHELL: I move that this should be submitted to the Committee on Conservation.

Carried.

THE PRESIDENT: There is a resolution here by Mr. Leofred.

THE SECRETARY: It has been moved by Mr. Leofred, seconded by Mr. Skaife, that the council take steps so that members of the Canadian Society of Civil Engineers be exempted to serve as jurors in the courts of justice of the Province of Quebec.

MR. HOLGATE: I think it would be rather trying to ask our council to assist us to escape our duties as citizens, and try to avoid matters of this kind. I do not think the society should take this matter into serious consideration.

MR. LEOFRED: It seems to me we should take some action in this matter, because all professional men practically are exempted from serving as jurors. The land surveyors are exempt, and I believe even dentists are exempt, and therefore I think engineers should be exempted.

MR. HOLGATE: If all juries were composed of engineers, I think we would have much better decisions.

THE PRESIDENT: Is this a Provincial matter or a Dominion matter?

VOICES: It is a Provincial matter.

THE PRESIDENT: Well, it seems to me we should let the Quebec branch deal with this matter.

MR. ST. GEORGE: I move with the approval of the annual meeting that this motion be referred to the local branch of Quebec as it is a provincial matter and they can do as they like about it.

MR. PARENT: Mr. Chairman, if this matter is to be submitted to the Quebec Branch, will we have the sympathy of this society? It is not only necessary that we have the approval of the society, but that we have its sympathy.

MR. TYE: I am very much in sympathy with what Mr. Holgate said. I don't think we should set an example of trying to shirk our duty, as citizens. I think the standard of juries should be raised, and not debased.

THE PRESIDENT: What is your pleasure, gentlemen?

(On a standing vote the president declared the motion lost.)

THE PRESIDENT: The next order of business is the reception of the reports of the scrutineers.

MR. MACKENZIE: May I ask a question?

THE PRESIDENT: Certainly.

MR. MACKENZIE: Is there any committee in existence now under which this subject would probably come—the disintegration of concrete surfaces in the intertidal space in sea water? If not, then I think the time has come when we should have a committee who would look especially into this matter. It is a fact with which we are not all acquainted, and there may be some difference of opinion upon it.

MR. JAMIESON: I think our committee on cement and concrete specifications have power to deal with this matter, and we have accummulated a large amount of data and information on this subject, but we have not yet been able to get sufficient definite information to make any report on it.

MR. JOHN KENNEDY: I agree with Mr. Mackenzie that it is a subject of the very greatest importance, and if that committee is not competent to deal with it—I mean if it is not within its powers—then some committee ought to be appointed.

MR. MACKENZIE: I think there is not any more important matter in the engineering profession in this country than this very subject, and the committee, I believe, must have had that power for some years, and so far as I can find out not very much has been done of a nature that would assist the engineers who are building such structures.

In the United States the engineers there—those who are working along the sea coast—have very definite ideas, so much so that they have abandoned the use of concrete in sea water to a large extent, and are using stone instead.

MR. JAMIESON: I may say in regard to the remarks of the last speaker that this is a comparatively new question, and that there are extensive tests being made in Germany

now, and the Scandinavian Committee composed of engineers and cement manufacturers, are now conducting a long-term test on this same subject, and also a great deal of work is being done in the United States. We must rely a good deal on that and get the result of all their tests, as far as possible, which we have been doing, and I think I have got all the data on that subject to date. By next year we will be able to do something definite.

MR. MACKENZIE: I beg to say that there is data scattered over this country which has not been collected; there is data scattered over this country which can be seen and the results noted. So far as I know, it has not been as yet.

MR. LEOFRED: I move that Mr. Mackenzie be added to the committee of the study and effect of sea water on cement work.

MR. JAMIESON: The committee already has power to add to its numbers, but we would be very glad to add Mr. Mackenzie to that committee.

THE PRESIDENT: The next order of business is the reception of reports of scrutineers on by-laws.

THE PRESIDENT: The next order of business is the report of the ballot for the election of members.

THE SECRETARY: I want to call the attention of the meeting to a little informality in regard to this. Mr. McAllister, who acted as the chairman of this committee, was not elected as the chairman. The gentleman who was elected did not report, and perhaps the society was out of session before it was noted that the chairman was not attending to business. A substitute had to be got for him, and Mr. McAllister acted as substitute. Perhaps the meeting would confirm the appointment of Mr. McAllister.

Carried.

THE PRESIDENT: I have much pleasure in declaring these gentlemen elected for the coming year, and I would ask the new president, Mr. Tye, to take the chair.

(The new president, Mr. Tye, here took the chair, amidst applause.)

MR. TYE: Gentlemen, I wish to thank you very much for your kind reception. I can only hope that you will be as well pleased when the year is over. (Applause.)

THE SECRETARY: Mr. President, the matter of the election of a Nominating Committee is one that is always dealt with under the by-laws by this meeting, and the mode of procedure under the by-laws is suggested by council. The mode of procedure which the council has adopted for the last two years is to request the branches to suggest two names at least for each office, and the annual meeting selects that one which commends itself. That provides for districts 3, 4, 5, 6, and 7. The recommendation with regard to district No. 1, which is the headquarters, has been made during the last two years by the local members of the council. Recommendation has also been made by the same local members of the council for district No. 2, which is the lower provinces and in which there is no branch. I have recommendations under that method for all the districts except the Quebec Branch No. 3, I understand that representatives of the Quebec Branch are prepared to make a nomination.

For District No. 1 I have one name only, that of J. L. Allan. For District No. 2 I have the nomination of Mr. R. S. Lee. For District No. 4, Mr. James White. The Ottawa branch sent only one name. For District No. 5 I think Mr. Haultain is prepared to make a nomination. He verbally gave me the name of Mr. T. C. Irving, Jr. For District No. 6 Mr. Frank Lea and Mr. E. P. Fetherstonhaugh. For District No. 7 Mr. J. C. Kennedy, Mr. E. C. Cartwright and Mr. H. L. Deutcher.

THE PRESIDENT: Is it your pleasure that you make any additional nomination to District No. 1?

MR. JAMIESON: Is it in order now to discuss this question? This does not seem a satisfactory way of proceeding, and it does not seem to give satisfactory results inasmuch as there has not been the full number nominated. Why not adopt the procedure of the American Society, which is to send out a paper for suggestions from all the members in each of the districts, and whoever has the greatest number of votes is usually appointed?

THE SECRETARY: That is done, Mr. Jamieson.

MR. JAMIESON: Well, over on the other side these papers are sent out and they prove very satisfactory. It gives every member of the society an opportunity to suggest for the Nominating Committee, and we must not lose sight of the fact that the Nominating Committee should be very carefully selected and every member of the society ought to be given a voice in the selection. It is essentially a point where they ought to have a say, because from that time on they do not have any say.

I would move, if it is in order to make a motion now, that this society adopt the same procedure as the American Society in regard to the Nominating Committee.

MR. SHANLY: I would like to say a word on the subject. If I remember rightly there was a time in this society when we used to send out circulars to all the members at the same time that the ballots went out, asking them for nominations for the Nominating Committee. The result, as I remember it, was if a man got half a dozen votes he might be elected. I remember I was proposed as a member of the Nominating Committee for one of the outlying districts, and there were, I suppose, a dozen other names submitted, each of them having one vote. I myself and one other member had two votes, and the tie was left to the decision of the annual meeting, and I was elected, I suppose, because I happened to be present. Therefore, I actually represented only two members of the society on that Nominating Committee. Now, if we send out ballots, as Mr. Jamieson suggests, it seems to me we will have the same trouble over again. We will have any number of names suggested and none of them will have an important majority.

MR. JAMIESON: Well, while that is true in the past, that is not necessarily true to-day. Conditions have very materially changed. It is, of course, up to the members themselves. Of course, if the members do not feel disposed to have a voice in the matter, very well and good, but this system is working well in the United States and they do get in larger returns. They get in a very large vote, and now the members are taking a great deal of interest in it, because it was satisfactory in the past. It was not the same procedure as I am proposing now, and the old, unsatisfactory system does not mean that the present one will be unsatisfactory.

THE PRESIDENT: Is it not more satisfactory to leave it to the branches and let them decide on whom they want?

MR. SHANLY: The trouble is we get a scattered vote. Each man votes independently.

MR. JAMIESON: Well, it will be representative, anyway.

MR. SHANLY: Under the present system the selection of the members nominated is left, as largely as possible, to the local branches. They are supposed to be in touch with their own members, and they can discuss the matter among themselves and send in a ballot which will represent the majority of their members. On the other hand, when each member votes independently you cannot get a majority.

MR. JAMIESON: That is exactly what I propose now.

THE PRESIDENT: And each district attends to their own part of the business themselves. Why should the council do that? Why not leave it to the branches? Then

the branches feel that they are represented, and that nobody else is interfering.

MR. JAMIESON: The American Society finds it very satisfactory, anyway.

MR. JOHN KENNEDY: Is there a branch in every district?

THE SECRETARY: Except at headquarters, and the lower provinces are without a branch. All the others are covered. In fact, in one district there are two branches.

MR. MYERS: I second the motion.

THE PRESIDENT: The business before this meeting now is the election of a representative for district No. 1.

MR. JAMIESON: Well, I asked if I was in order.

THE PRESIDENT: Well, I don't think it is in order at the present time. Has anybody else any other names to suggest?

THE SECRETARY: Mr. J. L. Allen is the representative for district No. 2. I am sorry there was an error.

THE PRESIDENT: Well, have you any other names to suggest for district No. 2, in addition to that of Mr. J. L. Allen? Is it your pleasure that Mr. J. L. Allen be the member for district No. 2?

Carried.

THE PRESIDENT: Now, for district No. 1, Mr. R. S. Lea.

Carried.

THE PRESIDENT: For district No. 3.

MR. PARENT: I am authorized by the Quebec branch to propose the name of Mr. E. A. Hoar.

Carried.

THE PRESIDENT: For district No. 4, Mr. James White has been suggested.

Carried.

THE PRESIDENT: For district No. 5?

MR. RUST: I move that Mr. T. C. Irving, Jr., be appointed.

Carried.

THE PRESIDENT: For the Manitoba district—district No. 6—the name of Mr. Frank Lea, and Mr. Fetherstonhaugh are suggested.

MR. LeGRAND: I beg to move that Mr. Frank Lea be appointed.

THE PRESIDENT: All in favor of Mr. Frank Lea please stand up.

Carried unanimously.

THE PRESIDENT: For district No. 7, the Vancouver branch, the names of Mr. J. C. Kennedy, Mr. C. E. Cartwright and Mr. H. L. Deutcher have been suggested.

THE SECRETARY: Mr. Cartwright is not eligible.

THE PRESIDENT: Very well, all in favor of Mr. J. C. Kennedy will please stand up.

Carried.

THE PRESIDENT: The only other business are votes of thanks to the railways of the Eastern Passenger Association, the Canadian Pacific Railway, the Montreal Tramways Company, the Dominion Bridge Company, the Canada Car Company, the McGill University and Doctor Barnes.

MR. MONSARRAT: I have very much pleasure in moving a hearty vote of thanks to be offered to these various companies and institutions and to Doctor Barnes.

MR. LeGRAND: I second the motion.

Carried unanimously, amidst applause.

MR. JAMIESON: Might I ask to put my motion that the Nominating Committee should be elected by ballot by the members at large from each district—that the members in each district should vote by ballot on their nominee for the Nominating Committee? In other words, that the secretary of each district should suggest the names.

THE PRESIDENT: Is not that an amendment to the by-laws?

MR. JAMIESON: Yes, I presume that would mean an amendment to the by-laws.

THE PRESIDENT: I am afraid that your motion is not in order at the moment. You will have to give notice of your motion before the first of October, so that it might be brought up at the next annual meeting.

MR. KEEFER: There is one motion I would like to make, and that I have very great pleasure in making, and that is, to thank the retiring officers of the society for the very able manner in which they have discharged their duties.

Carried, amidst applause.

MR. RUST: Mr. President, and gentlemen, on behalf of the retiring officers and myself, I wish to thank you very much for the kind way in which this vote has been proposed. We did the best we could, and that is about all I have to say.

MR. LINDSAY: I feel, as one of the visiting members, that I voice the sentiment of all of the visiting members in expressing our appreciation of the kindness extended to us by the Montreal members. As an Irishman, I suppose I wear my heart on my sleeve, but I am sure you have all made us very much at home here, and I assure you I appreciate it very much.

MR. LeGRAND: As a good Frenchman, I second the motion.

THE PRESIDENT: I declare the meeting adjourned.

THE DESIGN OF TALL CHIMNEYS.

(Continued from last issue.)

Prussian Government Rules.—In April, 1902, the Prussian Government issued regulations for the construction of chimney stacks. Square stacks to be designed for a wind pressure of 25½ lb. per square foot, with the centre of pressure at the centre of gravity of diametral vertical plane. Octagonal stacks 71 per cent. of the above pressure, and circular stacks 67 per cent.—Engineering Record.

Thickness of Brickwork.—Up to 150 ft. high, or 5 ft. inside diameter, the top length is generally one brick (9 in.) thick; above that height or diameter, the top length should be one and a half bricks thick, and the thickness should be increased by a 4½-in. set-off at every 20 ft. below the top. The outlet at top, and the throat or internal diameter at each set-off, should be of the calculated size to give the necessary area plus allowance for friction. Sometimes one hears it recommended that the top of the chimney should be contracted, to cause the expulsion of the gases at a greater velocity, and so to prevent down draught. It is said also that as the gases cool in their passage up the chimney they require a smaller sectional area to keep the velocity uniform. In general no attention is paid to either of these theories, and the section is kept as uniform as the other requirements will permit.

Batter.—If the diameter of the throat is kept uniform, and a 4½-in. set-off occurs at every 20 ft., the intermediate portions being of uniform thickness, a batter of 1 in 53.33 will be given, but the London County Council insist on a minimum batter of 1 in 48 = 2½ in. in 10 ft., and, besides that, it will be requisite in most cases to provide a firebrick lining for at least the bottom 15 ft. or 20 ft., having a thickness of 4½ in. and a clear space from the outer brickwork of 1½ in. to 2 in., necessitating a still greater batter.

Chimney Cap.—The chimney cap or cornice, by the London County Council rules, must not project more than the thickness of the brickwork upon which it rests. It may be of cast-iron castings, bolted together and filled with brick-

work, or of granite or other good weathering stone, the separate blocks being cramped together with galvanized iron cramps, or with an iron hoop sunk into the top and protected with cement, or of brickwork in cement.

Diameter at Base.—There is also an important rule of the London County Council which says: "The width of a shaft at the base, if square on plan, must be at least one-tenth, and if circular on plan, at least one-twelfth of the total height"

Firebrick Lining.—The firebrick lining must be entirely self-supporting, and have a clear space behind to allow for expansion and contraction independently of the main structure, which would be prevented if dirt and dust were to get behind it. It is therefore necessary to cover the top of the space by an over-sailing course of bricks built out from the inside of the main shaft, protecting the space, but allowing a clearance above the lining of ⅛ in. for every 5 ft. of its height, to permit of its expansion when heated. The average height of this lining is one-fifth height of shaft + 10 ft. A common height is 20 ft., and thickness 4½ in.; when of greater height it is necessary to make the lower part 9 in. thick. No air bricks should be inserted in the outer wall, as is sometimes done with the idea of cooling the air space, any such openings being very detrimental to the draught. The only possible inlet for air to the chimney shaft should be through the fire-bars or over the surface of the incandescent fuel.

The smoke inspectors of the London County Council have lately recommended openings into the chimney shafts near the bottom to reduce the smoke nuisance. The real effect is to dilute the smoke with air before it reaches the chimney top, so that it is not so black when expelled, but it does not reduce the actual amount of carbon emitted except so far as it tends to spoil the draught and so reduce the fuel consumption and boiler efficiency.

Stability.—Having drawn out the vertical section to suit the conditions, it will be essential to test the stability by calculation, but this is a somewhat complex matter and requires some preliminary data that will now be dealt with.

Materials and Weight.—The weight of each portion of the shaft—i.e., between each set-off—should be obtained separately so that the figures can be used singly or together. The weight will depend very much upon the material. Many chimney shafts are built of ordinary stock bricks and ground stone-lime mortar, and may be taken at 112 lb. per cubic foot. Others are built of solid machine-pressed bricks, and lias-lime mortar, and may be taken at 126 lb. per cubic foot. Some builders prefer perforated radial bricks and Portland cement mortar, weighing, say, about 100 lb. per cubic foot. Others consider that cement is too unyielding and that a shaft has greater ultimate stability if it sways lightly in a gale, which they fear the use of cement mortar might prevent. The bond usually adopted is one course of headers to four courses of stretchers, but sometimes tall chimneys are built in English bond, and occasionally in all headers.

The 450-ft. chimney at St. Rollox, Glasgow, is built in old English bond. The 300-ft. chimney at Johnson's Cement Works, Greenhithe, is built in Flemish bond. At Gosling's Cement Works, Northfleet, a 220-ft. chimney is built in stretching bond. At Barker's brick works, Worcester, the 160-ft. chimney is built with three stretchers, to one header. At the Surrey Commercial Docks, the 110-ft. chimney is constructed with all headers on the circular face. For the 100-ft. chimney at Farringdon Street Goods Station, Beart's patent perforated radiating bricks were used in the circular shaft, laid all headers on external face.

Hoop iron, galvanized or painted with cement wash, may be inserted at intervals of 5 ft. in height. The work should not be carried up too quickly, 3 ft. per day being quite sufficient unless the work is in cement.

The solid contents C of any portion of a circular shaft, having bottom outside diameter D in feet, top outside diameter d, uniform thickness t, and height h will be

$$C = \pi t h \left(\frac{D + d + \sqrt{Dd}}{3} - t \right)$$

and the weight will be C × weight of 1 cub. ft. of the material.

Safe Load on Material.—Assuming best workmanship and material, the maximum safe load may be taken as follows, being about 50 per cent. higher than would be allowed for live loads or inferior conditions.

	Tons per ft. super.
	Compression.
Granite	25
Portland and compact limestone	20
Hard York stone	15
Blue brick in cement	12
Stock brick in cement	10
Stock brick in lias mortar	8
Stock brick in grey lime mortar	6
Cement concrete 6 to 1	9
Deep clay (foundations not less than 10 ft. from surface), gravel and compact earth	3
Made ground rammed in layers	1½
	Tension.
Grey lime mortar (1 to 2)	1.0
Lias lime mortar (1 to 2)	1.5
Portland cement mortar (1 to 3)	2.0

Foundation.—It is important to note that a tall chimney should stand on an independent foundation, in order that the settlement or compression of the soil may be uniform. When a chimney is built close alongside a boiler-house, or within the four walls of a warehouse, it is sometimes placed on an extension of the other foundations and bonded in with other work, but this invariably leads to unequal settlement and subsequent cracks in the brickwork. It is evident that an ideal site would be on virgin soil of uniform character, preferably firm gravel, and not over old excavations or a filled-in water-course, or over old shaft workings, although all these positions have been adopted from carelessness or necessity.

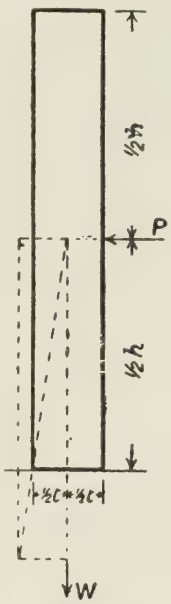

Fig. 6. Resultant of Thrust.

Principles of Stability.—The principles of stability can best be illustrated by taking a solid square brick pier, say 3 ft. square and 30 ft. high, weighing 1 cwt. per cubic foot. The total weight will be $3 \times 3 \times 30 \times 1 = 270$ cwt., the area of base $3 \times 3 = 9$ sq. ft., the mean pressure on base $\frac{270}{s} = 30$ cwt. per square foot. The resultant of the weight of all the parts passes vertically through the centre of gravity of the mass and cuts the centre of the base. If the wind be assumed to blow horizontally against one side the effect will be collected at the centre of the face and act with a leverage of half the height, as shown in Fig. 6, and the resultant of the two forces P and W will gradually approach the outer edge of the base as the wind pressure increases. Assuming that the pier could overturn on the outer edge as a fulcrum, without crushing, we have a case of simple leverage,

$W \times \frac{1}{2}t = P \times \frac{1}{2}h$, or $P = W\frac{t}{h} = 270 \times \frac{3}{30} = 27$ cwt., and

as P is made up of $3 \times 30 \times p$, we have $p = \frac{27}{3 \times 30} = 0.3$ cwt.

or 33.6 lb. per square foot.

Graphically the resultant will pass through the extremity of the base, as shown by dotted lines. Now, this is simple, but it is not true; the brickwork on the extreme edge would crush, and the pier would therefore overturn with a somewhat lower pressure. In practice we do not want our structures to overturn, and in order that they shall be safe when first built, we cannot allow any tensile stress on the inner edge. We therefore want to find what position the resultant must occupy for the pressure on inner edge to be reduced to zero. It will be observed that the wind, being a horizontal force, cannot add anything to the vertical force due to the weight of the structure, but it can increase the intensity of the pressure on a part of the base by forcing the resultant over towards one side and so altering the distribution. While the resultant is in the centre of base the pressure is uniform, as shown by the ordinates in Fig. 7, and as the resultant travels over to one side the pressure in-

Fig. 7. Fig. 8. Fig. 9.

Resultant of Thrust: Reaction According to Position of Resultant.

creases at one edge and diminishes at the other, as in Fig. 8, until finally the ordinates form a triangle, as in Fig. 9. This occurs in a rectangular base when the resultant falls at the extremity of the middle third, and is the origin of all false notions with regard to the efficacy of the middle third. The resultant falling within the middle third means no more than that the pressure then does not fall below zero on the inner edge; there is no guarantee that it may not be exceeding the safe load on the outer edge. On the other hand, there are many cases where the resultant falls beyond the middle third, and the structure is still only loaded within safe limits. In each of these examples the area of the shaded part, representing the forces of reaction, will be found equal, and it follows as a necessity that the maximum pressure indicated by the triangular Fig. 9 is double that shown by the parallelogram Fig. 7. In order to find the wind pressure to limit the resultant to this position we have to consider the altered leverage of the resistance; the weight of wall acting through its centre of gravity, Fig. 10, has now only a distance of $\frac{1}{6}t$ to the resultant, or centre of reaction, which is the virtual fulcrum; we therefore have the equation.

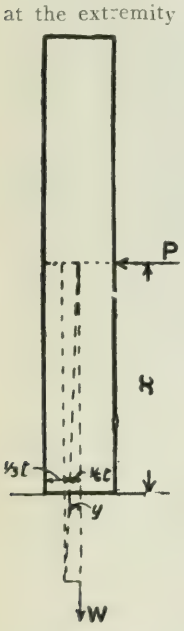

Fig. 10. **Resultant of Thrust.**

$W \times \frac{1}{6}t = P \times \frac{1}{2}h$ whence $P = \frac{W \times \frac{1}{6}t}{\frac{1}{2}h} = \frac{Wt}{3h} = \frac{270 \times 3}{3 \times 30} = 9$

cwt., and $p = \frac{9}{3 \times 30} = 0.1$ cwt. $= 11.2$ lb. per square foot.

as the maximum wind pressure instead of 33.6 lb., as found for simple overturning. This will produce a maximum intensity of pressure upon the base of $30 \times 2 = 60$ cwt. $= 3$ tons per square foot, which is below the safe limit, but we cannot increase it without reducing the pressure below zero on the inner edge, and although this might under certain circumstances be permissible, it is not generally considered desirable in the case of tall chimneys.

It will be well to use this illustration of a solid pier a little longer while we consider another point. Referring to the last figure, we can put the result another way. Making a plan of the base, as in Fig. 11, we can draw a triangle inside as shown by the ordinates, or shading lines, and if the base of the triangle represent the maximum pressure, then the ordinates show how the pressure reduces towards the inner edge. But we may look at it from another point of view, by assuming all the energy of resistance to be taken up by the particles within the triangle, so that they are all exerting the same pressure, while those outside the triangle are exerting none. This would give the same result, and it

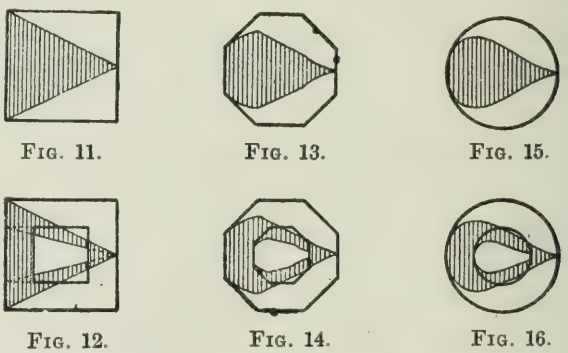

Fig. 11. Fig. 13. Fig. 15.

Fig. 12. Fig. 14. Fig. 16.

Resistance Areas of Different Sections.

explains better what is meant by resistance of area. The centre of gravity of the shaded triangle is the centre of effort of the resistance.

Application to Chimney Shafts.—The reason so much time has been spent over the plain brick pier is that we shall be able to deal with complex chimney shafts the more readily. Nearly all the different forms of bed joints can be reduced to a few simple diagrams. These are collected together in Figs. 11 to 16, the shaded part being the resistance area, or measure of effective resistance, of each. Another form of section may occasionally be found—viz., square, with two buttresses on each face—the resistance area of which would be found in a similar manner to the preceding, and the centre of gravity would be found experimentally by cutting out the area in drawing paper and suspending it from two points. These shaded portions have been described as resistance areas, although they correspond exactly with the inertia areas for a neutral axis coinciding with one edge. The reason is that in calculation account is taken of the actual conditions—viz., a uniformly distributed load, and a bending moment producing compression on one side and tension on the other side of a neutral axis passing through the centre of gravity of the section.

General Formula for Stability.—The general formula for a structure subject to a direct stress, and also to a bending moment is

$$K = m + \frac{M}{Z} \qquad k = m - \frac{M}{Z}$$

where K = maximum intensity of pressure in tons per sq. ft.
k = minimum intensity of pressure in tons per sq. ft.
m = mean ditto, due to direct stress, tons per sq. ft.
M = bending moment in foot-tons.
Z = modulus of section in foot-units.

This applies to all cases where the stress on the inner edge is not reduced below zero, and to such other cases as permit of a tensile stress.

d = deviation of centre of pressure when pressure becomes zero at opposite edge.

A = area of bed joint.

then $d = \frac{Z}{A}$

Also let—

W = superincumbent weight in tons.

A = area of section in square feet.

l = distance from resultant to edge of section in feet.

D = outside diameter or width in feet.

d = inner diameter or width in feet.

Then for solid square, Fig. 11—

$A = D^2$, $l = \frac{1}{3}D$, $Z = \frac{1}{6}D^3$

for hollow square, Fig. 12—

$A = D^2 - d^2$, $l = \frac{2D^2 - D^2}{6D}$, $Z = \frac{D^4 - d^4}{6D}$

for solid octagonal, Fig. 13—

$A = 2(\sqrt{2}-2)D^2$, $l = \frac{3}{8}D$, $Z = \frac{\sqrt{2}-1}{4}D^3$

for hollow octagonal, Fig. 14—

$A = (2\sqrt{2}-2)(D^2-d^2)$, $l = \frac{3}{8} \times \frac{D^2-d^2}{D}$, $Z = \frac{\sqrt{2}-1}{4} \times \frac{D^4-d^4}{D}$

for solid circular, Fig. 15—

$A = \frac{\pi}{4}D^2$, $l = \frac{3}{8}D$, $Z = \frac{\pi}{32}D^3$

for hollow circular, Fig. 16—

$A = \frac{\pi}{4}(D^2-d^2)$, $l = \frac{3}{8}\frac{D^2-d^2}{D}$, $Z = \frac{\pi}{32}\frac{D^4-d^4}{D}$

and if A be made use of to find Z,

Z = for solid square ..... $A \times \frac{1}{6}D$

" hollow square ..... $A \times \frac{1}{6}\frac{D^2-d^2}{D}$

" solid octagonal ..... $A \times \frac{3}{8}D$

" hollow octagonal ..... $A \times \frac{1}{8}\frac{D^2-d^2}{D}$

" solid circular ..... $A \times \frac{1}{8}D$

" hollow circular ..... $A \times \frac{1}{8}\frac{D^2-d^2}{D}$

It will be found that—

	Square.	Octagonal.	Circular.
l = for solid section	$\frac{1}{3}$D	$\frac{3}{8}$D	$\frac{3}{8}$D
" average hollow	$\frac{1}{4}$D	$\frac{1}{3}$D	$\frac{1}{3}$D
" infinitely thin	$\frac{1}{6}$D	$\frac{1}{4}$D	$\frac{1}{4}$D

and many designers are satisfied with these approximations, but for important work the exact distance should be obtained graphically or by exact calculation.

Ascertaining Stability.—Now the stability can be worked out from these diagrams and formulæ in two ways. Taking the 3-ft. brick pier as an example of a solid, square-bed joint, $Px = Wy$, but $y = \frac{1}{2}D - l = \frac{1}{2}D - \frac{1}{3}D = \frac{1}{6}D$, and $x = \frac{1}{2}h$, $\therefore P = W \times \frac{\frac{1}{6}D}{\frac{1}{2}h} = \frac{W}{3} \times \frac{D}{h}$, &c., as already worked out, when p was found = 11.2 lb. per square foot, and K = 3 tons per square foot. And by the second method $m = \frac{W}{A} = \frac{270}{9}$ = 30 cwt. = 1.5 tons, $M = p \times h \times D \times \frac{1}{2}h \times coeff = 11.2 \times 30 \times 15 \times 1 = 15{,}120$ ft.-lb. = 6.75 ft.-tons.

$$Z = \frac{1}{6}D^3 = \frac{3^3}{6} = \frac{27}{6} = 4.5 \text{ ft. units.}$$

$$K = m + \frac{M}{Z} = 1.5 + \frac{6.75}{4.5} = 3 \text{ tons per square foot as}$$

before.

In practice it will generally be necessary to work the other way round, and to make allowance for the taper of the portion under consideration, the stability of a chimney being usually measured by the maximum safe wind pressure. We know the maximum pressure on the bed joint will be twice the mean pressure, $K = \frac{W}{A} \times 2$, then the area must be such that K does not overstep the limits previously laid down by the tables of safe loads on materials.

(To be continued.)

STRENGTH VALUES FOR STRUCTURAL TIMBERS.*

By McGarvey Cliver, Director Forest Products Laboratory.

This circular brings together in condensed form the average strength values resulting from a large number of tests made by the Forest Service on the principal structural timbers of the United States. These results are more completely discussed in other publications of the Service, a list of which is given at the end of this circular, while most of them have also been furnished to the American Railway Engineering & Maintenance of Way Association and to various committees charged with the revision of the building laws of different cities. Their publication in the present form makes them available for quick reference by engineers, architects, builders, and other users of structural timbers.

The tests were made at the laboratories of the Forest Service, in co-operation with the following universities: Purdue University, Yale Forest School, University of California, University of Oregon, University of Washington, University of Colorado, and University of Wisconsin.

The Yellow Pine Manufacturers' Association, the E. P. Burton Lumber Co., the Redwood Manufacturers' Association, Oregon & Washington Lumber Manufacturers' Association, and the Pacific Coast Lumber Manufacturers' Association furnished, without cost, much of the material upon which the tests were made. Tests upon treated timbers, poles, crossarms, round mine timbers, and other structural forms are now being carried on.

Results.—Tables 1 and 2 give the average results obtained from tests on green material, while Tables 3 and 4 give average results from tests on air-seasoned material. The small specimens, which were invariably 2 by 2 inches in cross section, were free from defects such as knots, checks, and cross grain; all other specimens were representative of material secured in the open market. The relation of stresses developed in different structural forms to those developed in the small clear specimens is shown for each factor in the column headed "Ratio to 2" x 2"." Tests to determine the mechanical properties of different species are often confined to small clear specimens. The ratios included in the tables may be applied to such results in order to approximate the

*From Circular 189 Forest Service, U.S. Forest Service.

strength of the species in structural sizes, and containing the defects usually encountered, when tests on such forms are not available.

A comparison of the results of tests on seasoned material with those from tests on green material, shows that, without exception, the strength of the 2 by 2-inch specimens is increased by lowering the moisture content, but that increase in strength of other sizes is much more erratic. Some specimens, in fact, show an apparent loss in strength.

Table 1.—Bending Tests on Green Material.

Species.	Sizes. Cross section.	Sizes. Span.	Number of tests.	Per cent of moisture.	Rings per inch.	F. S. at E. L. Average per square inch.	F. S. at E. L. Ratio to 2" by 2".	M. of R. Average per square inch.	M. of R. Ratio to 2" by 2".	M. of E. Average per square inch.	M. of E. Ratio to 2" by 2".	Calculated shear. Average per square inch.	Calculated shear. Ratio to 2" by 2".
	Inches.	*Ins.*				*Lbs.*		*Lbs.*		*1,000 lbs.*		*Lbs.*	
Longleaf pine	12 by 12	138	4	28.6	9.7	4,099	0.83	6,710	0.74	1,523	0.99	261	0.86
	10 by 16	168	4	26.8	16.7	4,193	.85	6,453	.71	1,626	1.05	305	1.01
	8 by 16	156	7	28.4	14.6	3,147	.64	5,439	.60	1,368	.89	390	1.29
	6 by 16	132	1	40.3	21.8	4,120	.83	6,460	.71	1,190	.77	378	1.25
	6 by 10	180	1	31.0	6.2	3,580	.72	6,500	.72	1,412	.92	175	.58
	6 by 8	180	2	27.0	8.2	3,735	.75	5,745	.63	1,282	.83	121	.40
	2 by 2	30	15	33.9	14.1	4,950	1.00	9,070	1.00	1,540	1.00	303	1.00
Douglas fir	8 by 16	180	191	31.5	11.0	3,968	.76	5,983	.72	1,517	.95	269	.81
	5 by 8	180	84	30.1	10 8	3,693	.71	5,178	.63	1,533	.96	172	.52
	2 by 12	180	27	35.7	20 3	3,721	.71	5,276	.64	1,642	1.03	256	.77
	2 by 10	180	26	32.9	21.6	3,160	.60	4,699	.57	1,593	1.00	189	.57
	2 by 8	180	29	33.6	17.6	3,593	.69	5,352	.65	1,607	1.01	171	.51
	2 by 2	24	568	30.4	11 6	5,227	1.00	8,280	1.00	1,597	1.00	333	1.00
Douglas fir (fire-killed)	8 by 16	180	30	36.8	10.9	3,503	.80	4,994	.64	1,531	.94	330	1.19
	2 by 12	180	32	34.2	17.7	3,489	.80	5,085	.66	1,624	.99	247	.89
	2 by 10	180	32	38.9	18.1	3,851	.88	5,359	.69	1,716	1.05	216	.78
	2 by 8	180	31	37.0	15.7	3,403	.78	5,305	.68	1,676	1.02	169	.61
	2 by 2	30	290	33.2	17.2	4,360	1.00	7,752	1.00	1,636	1.00	277	1.00
Shortleaf pine	8 by 16	180	12	39.5	12 1	3,185	.73	5,407	.70	1,438	1.03	362	1.40
	8 by 14	180	12	45.8	12 7	3,234	.74	5,781	.75	1,494	1.07	358	1.31
	8 by 12	180	24	52.2	11 8	3,265	.75	5,503	.71	1,480	1.06	277	1.07
	5 by 8	180	24	47.8	11 5	3,519	.81	5,732	.74	1,485	1.06	185	.72
	2 by 2	30	254	51.7	13 6	4,350	1.00	7,710	1 00	1,395	1.00	258	1.00
Western larch	8 by 16	180	32	51 0	25 3	3,276	.77	4,632	.64	1,272	.97	298	1.11
	8 by 12	180	30	50.3	23 2	3,376	.79	5,286	.73	1,331	1 02	254	.94
	5 by 8	180	14	56 0	25 6	3,528	.83	5,331	.74	1,432	1 09	169	.63
	2 by 2	28	189	46 2	26 2	4,274	1.00	7,251	1 00	1,310	1.00	269	1 00
Loblolly pine	8 by 16	180	17	45 8	6 1	3 094	.75	5,394	.69	1,406	.98	383	1 44
	5 by 12	180	94	60 9	5 9	3,030	.74	5,028	.64	1,383	.96	221	.83
	2 by 2	30	44	70 9	5.4	4,100	1 00	7,870	1.00	1,440	1.00	265	1 00
Tamarack	6 by 12	162	15	57.6	16.6	2,911	.75	4,500	.66	1,202	1.05	255	1.11
	2 by 2	28	189	46 2	26 2	4,274	1.00	7,251	1 00	1,310	1.00	269	1 00
Western hemlock	8 by 16	180	39	42 5	15.6	3,516	.80	5,296	.73	1,445	1.01	261	.92
	2 by 2	28	52	51.8	12.1	4,406	1.00	7,294	1.00	1,428	1.00	284	1.00
Redwood	8 by 16	180	14	86 5	19.9	3,734	.79	4,492	.64	1,016	.96	300	1.21
	6 by 12	180	14	87.3	17.8	3,787	.80	4,451	.64	1,068	1.00	224	.90
	7 by 9	180	14	79.8	16.7	4,412	.93	5,279	.76	1,324	1.25	199	.80
	3 by 14	180	13	86.1	23.7	3,506	.74	4,364	.62	947	.89	255	1.03
	2 by 12	180	12	70.9	18.6	3,100	.65	3,753	.54	1,052	.99	187	.75
	2 by 10	180	13	55 8	20 0	3,285	.69	4,079	.58	1,107	1 04	169	.68
	2 by 8	180	13	63 8	21 5	2,980	.63	4,063	.58	1,141	1.08	134	.54
	2 by 2	28	157	75.5	19.1	4,750	1.00	6,980	1.00	1,061	1.00	248	1.00
Norway pine	6 by 12	162	15	50.3	12.5	2,305	0.82	3,572	0.69	987	1.03	201	1.17
	4 by 12	162	18	47.9	14.7	2,648	.94	4,107	.79	1,255	1.31	238	1.38
	4 by 10	162	16	45.7	13.3	2,674	.95	4,205	.81	1,306	1.36	198	1.15
	2 by 2	30	133	32.3	11.4	2,808	1.00	5,173	1.00	960	1.00	172	1.00
Red spruce	2 by 10	144	14	32.5	21.9	2,394	.66	3,566	.60	1,180	1.02	181	.80
	2 by 2	26	60	37.3	21.3	3,627	1.00	5,900	1.00	1,157	1.00	227	1.00
White spruce	2 by 10	144	16	40.7	9.3	2,239	.72	3,288	.63	1,081	1.08	166	.83
	2 by 2	26	83	58.3	10.2	3,090	1.00	5,185	1.00	998	1.00	199	1.00

Table 2.—Compression and Shear Tests on Green Material.

Species.	Compression ‖ to grain. Size of specimen.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	M. of E., per square inch.	Cr. str. at max. ld., per square inch.	Compression ⊥ to grain. Stress area.	Height.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	Shear. Number of tests.	Per cent of moisture.	Shear strength.
	Inches.			*Lbs.*	*1,000 lbs.*	*Lbs.*	*Inches.*	*In.*			*Lbs.*			*Lbs.*
Longleaf pine	4 by 4	46	26.3	3,480	.....	4,800	4 by 4	4	22	25.3	568	44	21.8	973
	2 by 2	14	34.7	.....	.....	4,400	.....	.....	.....	.....	.....	.....	.....	.....
Douglas fir	6 by 6	515	30.7	2,780	1,181	3,500	4 by 8	16	259	30.3	570	531	29.7	765
	5 by 6	170	30.9	2,720	2,123	3,490	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	902	29.8	3,500	1,925	4,030	.....	.....	.....	.....	.....	.....	.....	.....
Douglas fir (fire-killed)	6 by 6	108	34 8	2,620	1,801	3,290	6 by 8	16	24	33.7	368	77	35.8	631
	2 by 2	204	37.9	.....	.....	3,430	.....	.....	.....	.....	.....	.....	.....	.....
Shortleaf pine	6 by 6	95	41.2	2,514	1,563	3,436	5 by 8	16	12	37.7	361	179	47.0	704
	5 by 8	23	43.5	2,241	1,529	3,423	5 by 8	14	12	42.8	366	.....	.....	.....
	2 by 2	281	51.4	.....	.....	3,570	5 by 8	12	24	53.0	325	.....	.....	.....
	.....	.....	.....	.....	.....	.....	5 by 5	8	24	47.0	344	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	277	48.5	400	.....	.....	.....
Western larch	6 by 6	107	49.1	2,675	1,575	3,510	6 by 8	16	22	43.6	417	179	40.7	700
	2 by 2	491	50.6	3,026	1,545	3,696	6 by 8	12	20	40.2	416	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 6	6	53	52 8	478	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	4	30	50.4	472	.....	.....	.....
Loblolly pine	8 by 8	14	63.4	1,560	365	2,140	8 by 4	8	16	67.2	392	121	83.2	630
	4 by 8	18	60.0	2,430	691	3,560	4 by 4	8	38	44.6	546	.....	.....	.....
	2 by 2	53	74.0	.....	.....	3,240	.....	.....	.....	.....	.....	.....	.....	.....
Tamarack	6 by 7	4	49.9	2,332	1,432	3,032	.....	.....	.....	.....	.....	24	39 2	668
	4 by 7	6	27.7	2,444	1,334	3,360	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	165	36.8	.....	.....	3,190	.....	.....	.....	.....	.....	.....	.....	.....
Western hemlock	6 by 6	82	46.6	2,905	1,617	3,355	6 by 4	6	30	48.7	434	54	65.7	630
	2 by 2	131	55.6	2,938	1,737	3,392	.....	.....	.....	.....	.....	.....	.....	.....
Redwood	6 by 6	34	83.6	3,194	1,240	3,882	6 by 8	16	13	86.7	473	148	84 2	742
	2 by 2	143	72.1	3,490	1,222	3,980	6 by 6	12	14	83 0	424	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 7	9	13	74 7	477	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 3	14	13	75.6	411	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 2	12	12	66 5	430	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 2	10	11	55.0	423	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 2	8	12	56.7	396	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	186	75.5	569	.....	.....	.....
Norway pine	6 by 7	5	29 0	1,928	905	2,404	.....	.....	.....	.....	.....	20	26.7	589
	4 by 7	8	28 4	2,154	1,063	2,652	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	178	26 8	.....	.....	2,504	.....	.....	.....	.....	.....	.....	.....	.....
Red spruce	2 by 2	58	35.4	.....	.....	2,750	2 by 2	2	43	31.8	310	30	32 0	758
White spruce	2 by 2	84	61.0	.....	.....	2,370	2 by 2	2	46	50.4	270	40	58.0	651

Table 3.—Bending Tests on Air-Seasoned Material.

Species.	Sizes. Cross section.	Sizes. Span.	Number of tests.	Per cent of moisture.	Rings per inch.	F. S. at E. L. Average per square inch.	F. S. at E. L. Ratio to 2" by 2".	M. of R. Average per square inch.	M. of R. Ratio to 2" by 2".	M. of E. Average per square inch.	M. of E. Ratio to 2" by 2".	Calculated shear. Average per square inch.	Calculated shear. Ratio to 2" by 2".
	Inches.	*Ins.*				*Lbs.*		*Lbs.*		*1,000 lbs.*		*Lbs.*	
Longleaf pine	8 by 16	180	5	22 2	16.0	3,390	0.50	4,274	0.37	1,747	1.00	288	0.75
	6 by 16	132	1	23.4	17.1	3,470	.51	6,610	.57	1,501	.86	388	1.01
	6 by 10	177	2	19.0	8 8	4,560	.68	7,880	.68	1,722	.99	214	.56
	4 by 11	180	1	18 4	23.9	3,078	.46	8,000	.69	1,660	.95	251	.66
	6 by 8	177	6	20.0	13.7	4,227	.63	8,196	.71	1,634	.94	177	.46
	2 by 2	30	17	15.9	13.9	6,750	1.00	11,520	1.00	1,740	1.00	383	1.00
Douglas fir	8 by 16	180	91	20.8	13.7	4,563	.68	6,372	.61	1,549	.91	249	.64
	5 by 8	180	30	14.9	12.2	5,065	.76	6,777	.65	1,853	1.09	218	.52
	2 by 2	24	211	19.0	16.4	6,686	1.00	10,378	1.00	1,695	1.00	419	1.00
Shortleaf pine	8 by 16	180	3	17.0	12.3	4,220	.54	6,030	.50	1,517	.85	398	.98
	8 by 14	180	3	16.0	12.3	4,253	.55	5,347	.44	1,757	.98	307	.76
	8 by 12	180	7	16.0	12.4	5,051	.65	7,331	.60	1,803	1.01	361	.89
	5 by 8	180	6	12.2	22.5	7,123	.92	9,373	.77	1,985	1.11	301	.74
	2 by 2	30	67	14.2	13.7	7,780	1.00	12,120	1.00	1,792	1.00	404	1.00
Western larch	8 by 16	180	23	18.3	21.9	3,343	.57	5,440	.53	1,409	.90	349	.96
	8 by 12	180	29	17.8	23.4	3,631	.62	6,186	.60	1,549	.99	295	.81
	5 by 8	180	10	13.6	27.6	4,730	.80	7,258	.71	1,620	1.04	221	.61
	2 by 2	30	240	16.1	26.8	5,880	1.00	10,254	1.00	1,564	1.00	364	1.00
Loblolly pine	8 by 16	180	14	20.5	7.4	4,195	.81	6,734	.72	1,619	1.10	462	1.45
	6 by 16	126	4	20.2	5.0	2,432	.47	4,295	.46	1,324	.90	266	.84
	6 by 10	174	3	21.3	4.7	3,100	.60	6,167	.66	1,449	.99	173	.54
	4 by 12	174	4	19.8	4.7	2,713	.52	5,745	.61	1,249	.85	185	.58
	8 by 8	180	9	22.9	4.9	2,903	.56	4,557	.48	1,136	.77	93	.29
	6 by 7	144	2	21.1	5.0	2,990	.58	4,968	.53	1,286	.88	116	.36
	4 by 8	132	8	19.5	9.1	3,384	.65	6,194	.66	1,200	.82	196	.62
	2 by 2	30	123	17.6	6.6	5,170	1.00	9,400	1.00	1,467	1.00	318	1.00
Tamarack	6 by 12	162	5	23.0	15.1	3,434	.45	5,640	.43	1,330	.82	318	.75
	4 by 10	162	4	14.4	9.7	4,100	.54	5,320	.41	1,356	.84	252	.59
	2 by 2	30	47	11.3	16.2	7,630	1.00	13,080	1.00	1,620	1.00	425	1.00
Western hemlock	8 by 16	180	44	17.7	17.8	4,398	.59	6,420	.52	1,737	1.04	406	1.06
	2 by 2	28	311	17.9	19.4	6,333	1.00	10,369	1.00	1,666	1.00	382	1.00
Redwood	8 by 16	180	6	26.3	22.4	3,797	.79	4,428	.57	1,107	.96	294	1.05
	6 by 12	180	6	16.1	17.7	3,175	.66	3,353	.43	728	.64	167	.60
	7 by 9	180	6	15.9	15.2	3,280	.69	4,002	.51	1,104	.96	147	.53
	3 by 14	180	6	13.1	24.4	.....	.....	5,033	.64	.....	.....	291	1.04
	2 by 12	180	5	13.8	11.4	3,928	.82	5,336	.68	1,249	1.09	260	.93
	2 by 10	180	5	13.8	24.8	3,757	.79	4,606	.59	1,198	1.05	186	.67
	2 by 8	180	6	13.7	20.7	4,714	.90	5,050	.65	1,313	1.15	166	.60
	2 by 2	28	122	15.2	18.8	4,777	1.00	7,798	1.00	1,146	1.00	279	1.00
Norway pine	6 by 12	162	5	16.7	8.1	2,968	.56	5,204	.61	1,123	.97	286	1.02
	4 by 10	162	5	13.7	12 0	5,170	.98	6,904	.82	1,712	1.48	317	1.13
	2 by 2	30	60	14.9	11.2	5,280	1.00	8,470	1.00	1,158	1.00	281	1.00

Table 4.—Compression and Shear Tests on Air-Seasoned Material.

Species.	Compression ‖ to grain. Size of specimen.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	M. of E., per square inch.	Cr. str. at max. ld., per square inch.	Compression ⊥ to grain. Stress area.	Height.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	Shear. Number of tests.	Per cent of moisture.	Shear strength per square inch.
	Inches.			*Lbs.*	*1,000 lbs.*	*Lbs.*	*Inches.*	*In.*			*Lbs.*			*Lbs.*
Long-leaf pine	4 by 5	46	26.3	3,480	.....	4,800	4 by 5	4	22	25.1	572	52	20.2	984
Douglas fir	6 by 6	259	20.3	3,271	1,038	4,258	4 by 8	16	44	20.8	732	465	22.1	822
	2 by 2	247	18.7	3,842	1,084	5,002	4 by 8	10	32	18.1	584	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	8	51	20.2	638	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	6	49	21.0	613	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	4	29	24.8	603	.....	.....	.....
Short-leaf pine	6 by 6	29	15.7	4,070	1,951	6,030	8 by 5	16	4	17.8	725	85	.....	1,135
	2 by 2	57	14.2	.....	.....	6,380	8 by 5	14	3	16.3	757	.....	.....	.....
	.....	.....	.....	.....	.....	.....	8 by 5	12	5	15.1	730	.....	.....	.....
	.....	.....	.....	.....	.....	.....	5 by 5	8	6	13.0	918	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	57	13.9	926	.....	.....	.....
Western larch	6 by 6	112	16.0	.....	.....	5,445	8 by 6	16	17	18.8	491	193	15.0	905
	4 by 4	81	14.7	.....	.....	6,161	8 by 6	12	18	17.6	526	.....	.....	.....
	2 by 2	270	14.8	.....	.....	5,934	5 by 4	8	22	13.3	735	.....	.....	.....
Loblolly pine	6 by 6	23	.....	3,357	1,693	5,005	8 by 5	16	12	19.8	602	156	11.3	1,115
	5 by 5	10	22 4	2,217	545	2,920	8 by 5	8	7	22.9	679	.....	.....	.....
	4 by 8	8	19.4	3,010	633	3,920	4 by 5	8	8	19.5	715	.....	.....	.....
	2 by 2	69	.....	.....	.....	5,547	.....	.....	.....	.....	.....	.....	.....	.....
Tamarack	6 by 7	3	15.7	2,257	1,042	3,323	2 by 2	2	57	16.2	697	60	14.0	879
	4 by 7	3	13.6	3,780	1,301	4,823	.....	.....	.....	.....	.....	.....	.....	.....
	4 by 4	57	14.9	3,386	1,353	4,516	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	66	14.6	.....	.....	4,790	.....	.....	.....	.....	.....	.....	.....	.....
West hemlock	6 by 6	102	18.6	4,840	2,140	5,814	7 by 6	15	25	18.2	514	131	17.7	924
	2 by 2	463	17.0	4,560	1,923	5,403	6 by 6	6	26	16.8	431	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	4	6	15.9	488	.....	.....	.....
Redwood	6 by 6	18	16 9	.....	.....	4,276	8 by 6	16	5	25.4	548	95	12.4	671
	2 by 2	115	14.6	.....	.....	5,119	6 by 6	12	6	14.7	610	.....	.....	.....
	.....	.....	.....	.....	.....	.....	7 by 6	9	5	14.8	500	.....	.....	.....
	.....	.....	.....	.....	.....	.....	3 by 6	14	2	12.6	470	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 6	12	2	16.2	498	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 6	10	4	14.3	511	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 6	8	2	13.2	429	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	145	13 8	564	.....	.....	.....
Norway pine	6 by 7	4	15.2	2,670	1,182	4,212	2 by 2	2	36	10.0	924	44	11.9	1,115
	4 by 7	2	22.2	3,275	1,724	4,575	.....	.....	.....	.....	.....	.....	.....	.....
	4 by 4	55	16.6	3,048	1,367	4,217	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	44	11.2	.....	.....	7,550	.....	.....	.....	.....	.....	.....	.....	.....

NOTE.—Following is an explanation of the abbreviations used in the foregoing tables:
F. S. at E. L.=Fiber stress at elastic limit.
M. of E.=Modulus of elasticity.
M. of R.=Modulus of rupture.
Cr. str. at E. L.=Crushing strength at elastic limit.
Cr. str. at max. ld.=Crushing strength at maximum load.

due to seasoning. If structural timbers are seasoned slowly, in order to avoid excessive checking, there should be an increase in their strength. In the light of these facts it is not safe to base working stresses on results secured from any but green material. For a discussion of factors of safety and safe-working stresses for structural timbers, the reader is referred to the report of the committee on wooden bridges and trestles of the Railway Engineering & Maintenance of Way Association published in the Association Bulletin 107.

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THE EMPLOYMENT OF ENGINEERS.

At various times, in the columns of *The Canadian Engineer*, we have referred to the employment of engineers from outside Canada. In many cases our remarks have been challenged as being unfair to the outside engineer. Let us quietly and dispassionately look over the situation and see how matters stand.

In a recent address to the students in engineering in the University of Toronto, Mr. M. J. Patton, representing the Conservation Commission, stated that in gathering information and data from various sources for the compiling of the recently published "Reports on the Water Powers of Canada," those in charge of the work were surprised to observe that so large a proportion of plans for the hydro-electric development being carried on in Canada were prepared by foreign engineers. One of the students, in reply, said he hoped the Conservation Commission in their work would remember to conserve positions for the Canadian engineers, as it was becoming very difficult for the young graduate to obtain work along an engineering line. The above example, coming as it did from an official source, carries some weight, and we are constrained to ask, Why it is that our own consulting engineers are not doing this work?

One of the main objections to the employment of foreign engineers is the fact that a knowledge of local climatic conditions is essential to the success of engineering work. The design of hydro-electric installations, of sewage disposal works, and of many other departments of the engineering profession, are governed in a great measure by ice, snow and frost, and no man can do full justice to the work unless he is thoroughly acquainted and accustomed to the conditions. A consequence of this lack of knowledge is to be seen in the results of the recent installation of a central heating system for one of our large institutions of learning. This system was designed by a firm of consulting engineers from the United States, although the institution in question is government supported, and has on its list of engineering graduates dozens of men whose experience and training fit them for this work. This firm installed a gravity heating system against the opinion of many of their graduates, and the institution in question is now reaping the harvest in lack of heat and increased coal bills. Many similar instances might be quoted, but this particular one is rather flagrant. If the institutions which are turning out engineers will not use their own graduates, where can work be found for them?

We publish a letter this week from a Canadian, at present employed in the United States, who feels that we were unjust in our remarks a short time ago. The writer, however, does not appreciate our stand in the matter. There is certainly no objection to men from other countries coming to Canada and taking up their abode here. In fact, many of our engineers have done this very thing. They have, however, become Canadians. Likewise, many Canadians have left this country to take up work in other lands, and the writer of the letter mentioned is one of these. The engineers who come here to stay, and who come to take junior positions, will in turn become Canadians. On the other hand, it will be found that there is strong objection to foreign consulting engineers doing work in this country which can be done equally well by our own engineers.

The public bodies of the country should be the first to appreciate this principle and lend it their hearty support.

EDITORIAL COMMENT.

The series of articles on "Contracts for the Supply of Electric Power from the User's Point of View" is finished in this issue. We shall be glad to furnish the article in pamphlet form if there is sufficient demand from our readers.

* * * *

The old haunt of the student in vacation time has been cut off. The new regulations for fire rangers in Ontario have been issued by the Department of Lands, Forests and Mines, and in all the long list of rules the word "student" does not appear. The student in his intervals between study must find some other means of employment than canoeing and meandering through the northern wilds.

* * * *

The first of a series of articles on the "Principles of Specification Writing" is printed in this issue of *The Canadian Engineer*. When the series is complete we will publish the series in pamphlet form. The subject of specification writing is an exceedingly important one, and far too little attention is devoted to it. We are pleased to note that the Faculty of Applied Science and Engineering of he University of Toronto has taken the matter up, and Mr. C. R. Young, the author of this series in *The Engineer*, will deliver a short course on the subject to the students in engineering.

LETTER TO THE EDITOR.

The Editor:

Sir,—Many Canadian engineers engaged in their profession in the United States, like myself, temporarily or otherwise, will regret your ironical remarks on the appointment of a St. Paul man to the city commissionership of Moose Jaw.

It is to be hoped that many Canadian engineers at home will approve of the broadmindedness of the city of Moose Jaw in selecting the man who was considered to be best fitted for the position, irrespective of nationality.

The West has welcomed farmers and others from the United States to aid in building up the country. The engineer has been defined as a man who makes two blades of grass grow where only one grew before. Why is it not as consistent to select an engineer from the United States to help build up a city as it is to import American farmers to develop the country?

DONALD F. McLEOD, City Engineer.
Ithaca, N.Y.

IMPORTANT NATIONAL QUESTIONS DISCUSSED

Many unusually important points were brought to the attention of the new council of the Toronto Board of Trade on Thursday by Mr. G. T. Somers, the president. After quoting statistics respecting Toronto's remarkable growth, Mr. Somers urged the initiation of an actual movement for the immediate settlement and development of Northern Ontario. He showed that the continued industrial and business growth of Toronto and Southern Ontario would depend to some extent on the North, especially in view of the manufacturing tendencies in Western Canada.

The president also referred to the great loss of life and the large number of accidents in Toronto last year and quoted a recent article of The Monetary Times which told that in six years, 36,710 people have been killed or injured in Canada in accidents on steam and electric railways, at fires, and by industrial accidents. This is at the rate of 9,177 per annum. In other words, every day during that period 25 persons have been killed or injured. The Board, he said, could help to minimize this appalling record, so far as Toronto is concerned, by assisting to improve traffic rules, automobile speed regulations, the abolition of level street railway crossings in congested areas, and in many other ways easily apparent.

It was hoped, continued Mr. Somers, that early and serious consideration would be given by the Dominion Government to the enlargement of the Welland Canal. In this connection, he suggested that in planning for the enlargement of the Welland Canal it might be well for the government engineers to consider the question of incidental power production. Great plans for the development of power plants on the St. Lawrence above Montreal indicated that the Cornwall and Soulanges Canals may be cut out of the system and replaced by deep waterways created in connection with the building of power dams. If the expectations of the promoters of these and kindred projects were realized, the deepening of the St. Lawrence channels might be a source of profit to the people of Canada instead of a heavy bill of expense. While the proximity of Niagara and its great power plants must lessen the immediate value of power developed in connection with the enlargement of the Welland Canal, it must not be forgotten that the operation of the canal would require the pouring of a large volume of the waters of Lake Erie over the escarpment at Thorold. Should there be any truth in the rumor that six or seven locks of great depth and capacity are to be substituted for the large number of small locks on the present canal, the waste water from these locks might well become an important source of revenue to the government if utilized for power production.

Mr. Somers suggested the study of the lake levels by the Associated Boards of Trade, stating that a reduction of two or three feet in harbor depth is a serious calamity. Many excellent suggestions were also made regarding the good roads movement and these, we expect, will receive the attention of the Dominion Government and other authorities.

It was pleasing to note that Mr. Somers recommended earnest attention to the question of fire waste, and advised the support of the Board of Trade to the appointment of a provincial fire marshal. Too few public men and bodies are giving their thought to Canada's appalling record of fire losses.

The strengthening of the pure food and drug laws, the bringing of radial railways to the heart of Toronto, the appointment of a properly qualified industrial commissioner for Toronto, the present conservative valuation of Toronto real estate, were other matters discussed by the president, who also reminded his hearers that the advice of the Royal Commission on technical education is eagerly awaited. It is hoped that the membership of the Board will be 3,000 by the end of the year.

In connection with the radials, Mr. Somers said there were remunerative opportunities awaiting the enterprise of market gardeners around Toronto. Only a comparatively small proportion of the garden produce consumed in Toronto is grown in the immediate neighborhood. Secretary Wilson, of the United States Department of Agriculture, the other day drew attention to the question of utilization of lands near large cities, so that their markets for foodstuffs could be supplied with home-grown products. Only recently 15,000 tons of potatoes reached New York from Scotland for New York City consumption.

THE PRINCIPLES OF SPECIFICATION AND AGREEMENT WRITING.

By C. R. Young, A.M. Can. Soc. C.E.*

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First Article.

INTRODUCTION.

Present Status of Specification Writing.

Probably no detail of engineering work is given less attention in proportion to its importance than the preparations of specifications and agreements. Most engineers regard the task as a piece of unavoidable drudgery to be met with rare stoicism and gone through as quickly as possible. Hence, in office vernacular, specifications are said to be "ground out," not "written." In addition, they must only too often be prepared in an absurdly small remnant of time left between the completion of the plans and the calling for tenders, or, indeed, even after the invitations to tender have been issued or the advertisements published. Little thought can thus be given to the foundation of specifications on fundamental principles, and although each new undertaking of the engineer or architect nearly always differs materially from any other upon which he has been engaged, necessitating perhaps some important departure from former practice, no attempt is generally made to prepare a specification fully comprehending all the new and changed conditions. Instead, an ample collection of old specifications is gathered together and from this one and that one clauses are chosen which appear to be adapted to the case in hand, and with the good offices of the scissors and the paste are jumbled together to form the new document. It is therefore not remarkable to find that litigation arising out of Construction Contracts is sufficiently frequent and protracted to elicit a great deal of popular comment unfavorable to the engineer or architect responsible for the work.

Necessity for Increased Care and Thoroughness.

The engineer's success and his reputation with the general public, upon which his ultimate success depends, alike demand greater care in the preparation of specifications and agreements. Nowhere is haste more productive of sinister results than in this work. There are occasions in the consideration of any engineering undertaking when only the general features are of importance and indeed when the widest and most general view possible of the entire project should be taken in order that it may seem as a whole in its true perspective and in proper relation to existing conditions. But when it comes to the preparation of specifications and agreements, the "promoter" attitude of mind must give way to the close and painstaking scrutiny of details. In this work clearness, definiteness and strictest accuracy in all particulars are of the utmost consequence. Such a result can be secured only by the exercise of care and thoroughness in the work. The slighting of details and the covering up of ignorance and lack of proper consideration of the subject by such expressions as "the work shall be done to the satisfaction of the engineer," while apparently effecting a present saving of time are almost certain to later entail a much greater loss of time to all concerned and perhaps considerable financial loss as well.

*Consulting Structural Engineer, 318 Continental Life Building, Toronto.

Scope of the Proposed Discussion.

In the hope that some assistance might be afforded to those who are interested in the improvement of the present character of specification and agreement writing, the writer proposes to discuss the principles of the subject in this and succeeding papers. What is said will not concern the merits of, or the desirability of specifying, any type of construction, design, detail or method, but, rather, the art or science of fully, accurately and unambiguously describing the features and details which already have been adopted. The method to be followed will therefore not be the quotation of a number of authoritative specifications from which the reader could select such portions as appeared to be adapted to his own work, but, instead, it is proposed to state and illustrate in so far as possible the **fundamental principles** upon which all specifications and agreements should be based. By a thorough understanding of these principles, and only by such means, is it possible for anyone to prepare satisfactory instruments of this kind.

Because of the limitations of available space it will be necessary to confine the present discussion to the commoner forms of construction contracts. While it is fully recognized that many things might profitably be said concerning the distinctive features of specifications and agreements for the various forms of "secured-cost" contracts, attention will be chiefly directed to the "unsecured-cost" contract, the one most commonly employed, and the one nearly always adopted in public works.

The Engineer's Limitations.

It is obvious, of course, that the engineer cannot safely dispense with the services of the solicitor, as a result of gaining some little acquaintance with the principles of contract law. No one with experience will dispute the old observation that "A man who is his own lawyer has a fool for a client." For most contracts, however, a lawyer is not consulted in any event, and if the engineer has some familiarity with the essentials of proper specifications and agreements, his work is likely to be much more satisfactorily performed than if he does not possess such information.

PRELIMINARIES TO THE CONTRACT.

Procedure of the Owner in Allotting the Work

When a person, company, municipal corporation or government, and which for brevity we may call the Owner, desires to carry out a piece of engineering construction, he, or it, procures the services of an engineer or architect specially skilled in the particular class of work under consideration and who in continuous consultation with the Owner develops designs and details conforming to the needs and purposes of his client. The latter not generally possessing the knowledge, experience, plant or organization essential to the successful and speedy prosecution of the actual work of construction prefers to delegate the risks and responsibilities incident to such a project to someone else especially qualified to undertake them, and at the same time, before commencing work, to ascertain with some accuracy the final cost and the time of completion. It is not in general desirable for him to entrust both the preparation of designs and the actual work of construction to

one person or firm, because on one hand, the engineer or architect is not likely to possess the special experience or organization required for the efficient performance of the work in the field, and on the other hand, most construction firms are not especially well qualified to advise the Owner concerning the more troublesome engineering or architectural features of the project. Further, the value of a check would be lost, if the Owner were to place his case wholly in the hands of one person. If the latter proved dishonest, the Owner might be grossly deceived with little risk of detection. Thus it has come to pass that the Owner commonly places the actual work of construction in the hands of a third party, called the Contractor, who supplies all materials, performs all labor, and delivers up to the Owner in a stated time the desired structure, work or article, complete and ready for use.

The Preparation of Plans, Specifications, and Agreements.

In order that the Contractor may know precisely what is required by the Owner, and also that the Owner may ensure his being supplied with what he agrees to pay for, the latter's engineer (or architect) prepares graphic or written statements of the work to be performed and of the business relations which the Owner proposes shall subsist between himself and the Contractor during the progress of the work. Those requirements which can best be shown graphically, such as dimensions, shape and size of parts or quantity and distribution of materials are preferably embodied in **plans**, while the quality of materials, workmanship and methods of construction lending themselves readily to written description are set forth in **specifications.** In the latter are also stated certain general relations, as of authority, which it is proposed shall govern the Owner and the Contractor or their representatives in the actual physical construction of the work. A formal **agreement** is also drawn up and attached to the specifications setting forth the general nature of the proposed arrangement between the parties, including the financial or other valuable consideration involved and to this it is expected that both the Contractor and the Owner will affix their signatures upon the award of the contract.

Because of the complexity and multiplicity of details in most constructional projects it is essential that everything affecting the extent or cost of the work should be clearly set down in writing or on plans before the award of the contract, not only for the information of the Contractor in making up his bid, but for the subsequent guidance of the Contractor, the Owner's inspector and all others having to do with the work. While oral agreements may be satisfactory for trifling pieces of work where the parties are both of unquestionable integrity, the uncertainty of memory and sometimes the willingness of one party to take an unfair advantage over the other demands that all the requirements of the Owner and all understandings between the Owner and the Contractor should be reduced to writing or shown on sketches or plans.

The Closing of the Contract.

Having entertained bids or proposals for the work up to a specified date, the Owner awards the contract upon the advice of his engineer, and the successful bidder is required to sign the agreement, specifications and plans which then collectively become the **Contract.** The agreement is sometimes termed "the contract," but since the specifications and plans are declared in the agreement to be a part of the contract, this practice is therefore manifestly erroneous.

THE COMPOSITION OF AN ENGINEERING CONTRACT.

Length and Amount of Detail.

The character of the work in hand is the most important factor in determining the length and amount of detail in an engineering contract. Where the work is simple or of small extent a letter from the Contractor to the Owner offering to supply all materials and perform all labor for a certain consideration may be sufficient. If the communication refers to a plan or sketch furnished by the Owner it should contain the Contractor's pledge to execute the work in accordance with such plan or sketch. On the other hand, the Contractor may himself submit a plan with his letter setting forth what he proposes to do for the compensation mentioned. The specifications are also of very brief character when the Owner purchases a machine, article or commodity covered by letters patent or which is subject to some degree of artificial or natural monopoly, and which is therefore produced in accordance with the Contractor's and not the Owner's ideas. Unless competition is very keen, manufacturers are not eager to supply machines or other articles to special plans and specifications prepared by the engineer, for this means changing the character of their product, methods and processes which had perhaps been arrived at and constituted shop standards after many years of experiment and observation. In some instances the process of manufacture and the materials employed are secret, and, since the purchaser could have no knowledge of these, they manifestly could form no part of the specifications. The purchaser therefore does not usually submit plans to the bidder in the case of machinery, patented appliances, and many other articles and commodities, but limits his specifications to a brief statement of the required performance or ability to meet certain specified tests.

Where the piece of construction is built in accordance with the engineer's, and not with the contractor's, ideas, such as railroads, canals, tunnels and often bridges and buildings, plans and specifications of an extensive character must be prepared, and the difficulty of framing a proper contract is considerably augmented. Added to the necessity of clearly specifying what is required in, and of, every part of the finished work is the need of ensuring that unfavorable natural or climatic conditions, difficulties of transportation or labor troubles, all of which greatly affect field operations, shall not preclude the attainment of the desired result. Although, in theory, it is only in the result that the Owner is interested, he must also reserve the right to prevent the Contractor from continuing in a course which is reasonably certain to culminate in failure. Many contingencies must therefore be provided for in work constructed to order in the field, and the specifications grow into many typewritten or printed pages. The agreement is also properly more detailed than that pertaining to the simpler classes of work already mentioned.

The length and fullness of the specifications will also depend on the nature of the arrangement with the Contractor. If the engineer prepares the complete designs and the Contractor is only required to construct the work at his shops or in the field in accordance with such designs, the specifications need only deal with construction. On the other hand, if the Contractor is re-

quired to prepare the designs and do the actual work of construction as well, the specifications must of necessity be much fuller than in the first case. Experience has shown that the latter method is objectionable on a number of grounds. In the first place it leaves the Contractor free to adopt many faulty features of design which for the sake of brevity could not all be expressly forbidden in the specifications, but which would have been rendered impossible by the engineer designing the work himself. Again, unless all contractors bid on the same design, viz., that of the engineer, those who have least to lose will submit low bids on questionable or flimsy designs of their own, which may inadvisedly be accepted by the Owner to his subsequent sorrow. This method also entails much trouble in case changes are desired, for unless the engineer has clearly shown by plans of his own exactly what he requires, the Contractor will generally contend that his own plans supply all that was called for in the specifications. Thus, it is desirable wherever possible to have bids based not only on specifications but on full detail drawings prepared by the engineer, rather than on the Contractor's design or even on general drawings prepared by the engineer.

Another feature of the arrangement between the Owner and the Contractor materially affecting the length and amount of detail of the contract is the manner in which the Contractor receives his profit. If the contract is a so-called "lump-sum" one, the amount of detail and the care and preparation of the necessary documents is much greater than for "secured-cost" contracts, such as those on a "cost-plus-a-percentage" and "cost-plus-a-fixed-sum" basis. On a "lump-sum" contract the Contractor naturally strives to reduce the cost to a minimum since the difference between his bid and the cost is all gain. Special care must therefore be taken in preparing the specifications to prevent the Contractor scamping the work in order to increase his own profit.

In accordance with the complexity of the work and the character of the contracting parties, construction contracts may thus be composed of agreements, specifications and plans in varying proportions. For all, there should be some form of agreement, although perhaps quite simple, since in this is disclosed the intention of the parties and the general basis on which the arrangement is made. Lacking such written statement, the settlement of disputes is often attended with great difficulty, as an attempt must be made to prove by oral evidence what might have been established by a few lines of writing.

AN ACTUAL SAVING OF WOODEN FORMS.

There are three general types of coal pockets in use today, the all-timber, the all-concrete, and the combination type of concrete and timber. A great many of the latter design have been erected according to plans of Monks & Johnson, architects and engineers, of Boston, who are able to reduce the cost of coal pockets considerably by using the forms for the reinforced concrete work in constructing a part of the wooden walls and bins of the coal pocket. The cost of all reinforced concrete coal pockets range from $6.00 to $7.50 per ton of capacity, but in the combination type, where the supports and the floors are of concrete but the walls are of timber, the cost is generally about $5.00 per ton of capacity, and this in no small part is due directly to the actual saving of the forms by incorporating them in the coal pocket itself.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.

Annual Meeting, January 9, 1912.

The third annual meeting of the American Society of Engineering Contractors was held in New York City on the 9th day of January, 1912.

In the forenoon members of the society visited, in a body, the new Grand Central terminal, at the invitation of Mr. W. L. Morse, Terminal Engineer of the N.Y. Central & Hudson River R.R. Co. They were escorted by Mr. E. D. Sabine, first assistant terminal engineer; Mr. W. C. Goddard, terminal architect's engineer, and their assistants.

It is needless to say that great interest was evinced by the members who were fortunate enough to view the remarkable work accomplished and still going on, which work will result in probably the greatest railroad terminal in the world. Particular interest was manifested in the method of coating all the steel columns, beams, etc., in the lower level with cement. The mortar is applied directly through the "cement gun" by the agency of a blast of compressed air.

At the afternoon session, which was devoted to a business meeting, the address of the retiring president of the society, Mr. W. R. Harris, was read. Mr. Harris, who, for nearly one year, has been located in the Canadian Northwest at Regina and Saskatoon, Sask., was unable to be present. He stated that even in those distant provinces much interest is evinced regarding the work undertaken by this society, which is about to be manifested by the organization of branches.

We read and hear much these days relative to workmen's compensation for injuries sustained. Undoubtedly, many superficial observers show little interest in this question unless directly affected in legislation of this character with the result that many laws have been passed which, if enforced, will be bound to affect seriously contractors and, ultimately, the public. It goes without saying that every added expense saddled on the contractor through such laws is not going to be assumed by him, but must be paid by the owner, whether he be an individual or the public. This is simply a business proposition.

Mr. Harris related that during the last session of the local Parliament in Saskatoon a law was passed whereby all workmen, except farm laborers, are entitled to compensation for injuries, whether sustained through carelessness or not. This is class legislation of the worst kind, because the farmer, who employs the larger part of his force only a short time each year, is not affected, while the manufacturer and the contractor are liable. Furthermore, the law is unfair in its effect on the bids of various contractors. The man who is responsible and, therefore, is able to obtain liability insurance must pay the higher premiums caused by this Act, and, necessarily, must include such cost in his bid. On the other hand, the contractor who, because he is not financially responsible, or for some other reason, does not secure such insurance, would not have to figure on such an additional expense and is thereby able to reduce his bid accordingly.

The remedy is an organization like this society which, when necessary, will oppose reckless legislation and insure that, if general compensation statutes of this kind are deemed necessary, each man who employs labor shall be affected equally.

A point of interest to all engineers who have to specify tests for cement is one brought out by Mr. Harris. He stated that, under the present specifications, tests required for cement fail to provide the safeguards anticipated. For

instance, while the usual method of taking one barrel in every ten of a shipment as a sample of the material, the method of mixing the samples is not satisfactory. It is provided that, to determine the characteristics of a shipment, the individual samples may be mixed and the average tested. This may not be objectionable where the cement is used in massive concrete subject to compression only. In reinforced concrete, however, because comparatively thin members are used, this method should not be allowed.

The reasons given by Mr. Harris for his position are as follows:—

It is acknowledged that 80 per cent. good cement will carry 20 per cent. poor cement. If the average sample of a shipment shows only 20 per cent. bad material it is, according to standard specifications, allowable. However, the mixing which is done with the sample is, of course, not repeated with the bags of cement, since it would be impracticable to take a car load shipment, mix it and remeasure it to secure the proper proportion.

The result is that where mixing up a batch of concrete, the sacks used may contain as much as 50 per cent. bad cement, and just as likely as not this concrete may be placed in a portion of the structure where only the best material should be used.

Again, a shipment of cement may contain the products of different mills, cement which may be different in regard to setting time, fineness, etc. It is bad practice to use two brands of cement in the same concrete mixture, but if the products of several mills are placed in sacks of a common brand, it is impossible to tell by looking at the sack whether the contents of a car would run uniform or not, except by individual tests.

This question is of much importance to architects, engineers, contractors, and manufacturers of cement products. Mr. Harris recommended concerted action by this society with other technical societies to eliminate the foregoing defects of the present specifications.

After Mr. Harris' address was read the result of the election of officers was declared. The following officers were elected:—

President—Maj. C. E. Gillette, of Philadelphia, Pa.

1st Vice-President—H. J. Cole, of New York, N.Y.

2nd Vice-President—John Marshall, Regina, Sask., Can.

Directors—W. B. Bamford, of Belmar, N.J.; Carl Weber, of Los Angeles, Calif.; C. A. Mees, of Charlotte, N.C.

President Gillette then assumed the chair, and after some introductory remarks he called for a report of the treasurer, which was presented. This was followed by a report of the secretary, in which he outlined the work accomplished by the society during the past year Among other things, the secretary stated that 130 new members had been added to the rolls of the society during 1911, an increase of 20 per cent. of the active membership.

This was followed by discussions relative to various features of the work to be done by the society, among which is the gathering of cost-data.

Mr. Shannon, of Jersey City, and Mr. Bosch, of Harrisburg, both contractors, stated that, in their opinion, it could not be expected that contractors, generally, would care to divulge their costs, since they usually consider this information as their personal property, or what may be called their trade secrets. Mr. Frank B. Gilbreth, the well known contractor, however, took the view that contractors are bound to benefit from interchange of ideas and publication of costs. He stated that if many of the contractors who bid on construction work only knew more about costs there would be less ruinous bidding than there is at the present time. It has been the experience of large manufacturers that they have benefited from the publication of their costs in full detail, by the fact that competitors could see for themselves that the margin of prolt was not so large as to allow great risk to be taken.

It was agreed, however, that cost-data of itself has not much value unless together with it is given full details of the method of doing the work, the character of labor, hours of work and an explanation of all conditions that would affect the cost.

At the evening meeting the elected president, Major C. E. Gillette, delivered an interesting address in which he pointed out that the society, although it is an association of contractors and engineers is, primarily, organized to do something for the public good. Major Gillette also pointed out that, whereas every class of labor is organized, contractors alone are not.

He stated that this society should take steps to point out and eliminate waste in large works, waste which is often due to errors in design. Very few designs are made from the point of view of final cost, and in that respect much benefit should result from co-operation and interchange of ideas between engineers and contractors.

Another feature in contracting work, which causes the contractors great loss, and which, ultimately, affects the public, is unreasonable inspection. This requires attention, because unfair inspection has been the cause of much trouble in contract work. The United States Government, particularly, suffers from that trouble, and it is doubtless the reason why it must pay much more for structures of any kind than private individuals or corporations.

Major Gillette recommended that the society use its best efforts to write on the statute books of at least one State, a good, complete, real law that will require fairness, and the avoidance of favoritism and graft in public, government, state, and municipal contracts. By doing that one thing, the society will have justified its existence over and over again. Of course, it is appreciated that it is not possible to legislate honesty into public officials, but, at least, a valid and comprehensive law of this kind, backed by the active influence of a large organization, will doubtless serve to make the way of the trangressor much harder than it is at the present time.

The next point that the speaker referred to was the question of practical specifications. Only too often specifications are written that would require a miracle to carry out, in fact, they are an absolute impossibility; yet contractors are constantly asked to bid on such specifications and they must do it, if they want work. The result is that no end of trouble is experienced. Ultimately the cost must be shouldered by the public, who is powerless to prevent it. Therefore, it behooves an organization like this society to avail itself of the unexcelled opportunity that is now available to accomplish something of lasting benefit, not only to contractors, but also to the public.

The remainder of the evening was devoted to a talk by Mr. J. R. Wemlinger, on "Methods and Costs of Driving and Pulling Steel Sheet-Piling." This was illustrated by means of one hundred and twenty-five lantern slides, showing all known methods of installing sheet-piling of all kinds in United States and foreign countries.

The headquarters of the American Society of Engineering Contractors are at 13-21 Park Row, New York City.

AMERICAN WATER WORKS ASSOCIATION.

The thirty-second annual convention of the American Water Works Association will be held at Louisville, Ky., June 3rd to 8th, 1912, with headquarters at the Seelbach Hotel. Alex. Milne, President; J. M. Diven, Secretary.

CONTRACTS FOR THE SUPPLY OF ELECTRIC POWER FROM THE POWER USER'S POINT OF VIEW.

VI.

By H. E. M. Kensit, M.I.E.E.

The clause dealing with penalties for failure of or interruption in the supply is a thorny one, but usually fully understood in its legal aspects by the lawyers responsible for settling the contract. There are, however, certain considerations due to inherent necessities and probabilities in ordinary operation of the power plant that should be taken into account.

It should be borne in mind that any customer's own power plant must, and inevitably will, sooner or later break down or need stoppage at inconvenient times for repairs, and in many cases such stoppage may be seriously prolonged by the necessity of sending to distant points for new parts or skilled workmen. The risk of lengthy interruption in the supply from a power company is less than in the case of a private plant, because the power company has usually reserve plant, a full stock of spare parts, and skilled men at hand to carry out repairs. It is but seldom that a power company can be charged with negligence in regard to maintaining the supply, but nevertheless all moving machinery must need stoppage at times and all transmission lines must need repair from time to time.

The conditions of the penalty should, therefore, be reasonable, both as to duration of interruption and payment.

As the drafting of the penalty clause is generally a contentious matter, the following examples from some existing contracts may be useful for reference:—

(1). "Accidental Interruption.—This agreement to furnish electric energy is made expressly subject to interruptions or diminutions in the supply of said energy which may be due to causes beyond the reasonable control of the power company, provided that in any such case there shall be an abatement in the payment by the customer to the power company amounting to twice the sum which the customer would have paid for the actual time of each interruption for the quantity by which the supply of electric energy is diminished during the interruption. The power company shall not be liable for any further loss or damage with respect to such interruptions or dimensions beyond such abatement in the payment as aforesaid.

"Intentional Interruption.—If it becomes necessary for the purpose of repair or other good cause to make an intentional interruption, the power company shall give due notice to the customer and make such interruption at that time during the 24 hours following receipt of said notice as shall be reasonably selected by the customer, and such interruption shall not last for more than one hour in any consecutive 24 hours, nor shall the total number of such intentional interruptions amount to more than six in any calendar month, provided further that, should such intentional interruptions extend beyond the above specified periods a deduction shall be made from the payment for energy of a sum equal to twice the amount which the customer would have paid for a supply during the periods of interruption in excess of those specified above."

In the above case the supply was to a factory operating 24 hours a day, so that interruption at any hour represented loss to the customer.

(2). "That in case the producer shall not at all times furnish said energy as aforesaid, it will rebate to the customer such sum as equals the charge made by it against the customer for energy for and during the period of time only wherein energy has not been so furnished, and such rebate is hereby fixed as liquidated damages for and on account of such failure to furnish said energy, and shall be received by the consumer as in full settlement by the producer of all claims and demands of the consumer for injury and loss directly and indirectly resulting by reason thereof."

(3) "The power company shall not be liable for any penalty on account of breakdown of their generating plant, transmission line, transformers, or other apparatus, but the power company hereby agrees that should it make default after the above specified date for the commencement of supply in affording a full and sufficient supply of energy as provided in this agreement (such default not being due to breakdown or to stoppage for temporary purposes at a time agreed upon with the customer), the power company shall be liable to pay to the customer a penalty of $10 per hour during the continuance of such default. In the event of the power company failing to supply from any cause for a week at one time or 10 whole days in one month, the customer shall have power, by notice in writing to the power company, to cancel this contract."

(4). "In case the commission or the company should at any time be prevented from delivering said power or any part thereof.....by strike, lock-out, riot, fire, invasion, explosion, Act of God or the King's enemies, or any other cause reasonably beyond their control, then the commission shall not be bound to deliver such power during such time.....

"If and so often as any interruption shall occur in the service of the company due to any cause or causes, other than those provided for by the next preceding paragraph hereof, the commission shall recover and pay to the said corporations as liquidated and ascertained damages, and not by way of penalty, as follows: For any interruption of less than one hour, double the amount payable for power which should have been delivered during the time of such interruption; and for any interruption of one hour or more, the amount payable for the power which should have been delivered during the time of such interruption and twelve times the last mentioned amount in addition thereto." "Hydro-Electric Commission of Ontario."

The above clauses cover quite a wide range of conditions and ideas as to how they should be met.

When such a clause is under consideration both sides are financially interested and biased; the power user often forgets the risk he has been running of heavy loss from the breakdown of his private power plant and endeavors to exact the largest penalty possible for any interruption, however short; the power company wish to avoid all liability as far as possible.

Let us endeavor to examine in a disinterested way what are the conditions under which it is reasonable to exact a penalty for interruption of supply.

The interruption or diminution may occur from:—

(1). Intentional Stoppage for necessary repairs, connection of new customers, etc. The time of such stoppage can generally be arranged with the customer to cause him no inconvenience, but the clause should call for as long notice as possible and guard against too long a stoppage overlapping with working hours. If this occurs, or if it is a case of a works operating the whole 24 hours, then a rebate on the account for power is just and reasonable.

(2). Unforeseen Breakdowns of plant, lines or other apparatus. In spite of every diligence and foresight such occurrence must happen sometimes. When they do it generally causes more direct loss to the power company than to the the individual customer, and furthermore, unexpected and accidental total interruption causes heavy indirect loss to the power company in a loss of prestige and confidence which hinders obtaining new customers at favorable rates. It may usually be safely assumed that the power company will use

more than "reasonable diligence" to avoid such occurrences, and it is not reasonable to exact heavy penalties in such cases.

At the same time the power company have taken a contract to supply power continuously and the matter of breakdown is very largely, though not entirely, in their control; by expending capital in reserve plant and duplicate transmission lines, and employing competent and well-paid assistants they can very largely minimize the risk.

Furthermore, there is always some risk that a breakdown having occurred, the utmost possible will not be done to shorten the time of interruption; to do the utmost possible often involves heavy expenditure to save a few hours, such, for instance, as sending heavy parts of machinery by express instead of freight, executing expensive temporary work, paying high wages for overtime, etc.; it is but human nature that heavy expenditures to save a short time will be shirked if there is no counterbalancing penalty, and yet even a few hours interruption may mean heavy loss to a manufacturer.

The end to be desired, therefore, is not to heavily penalize a company for an unavoidable breakdown, but to secure that the length of interruption is as short as humanly possible.

This might be secured by arranging the penalty on a sliding scale; the penalty for the first hour could be very moderate and thereafter it could increase rapidly with every additional hour of interruption; thus, if it was to start at $10 for the first hour and to increase by 50 per cent., it would be $15 for the second hour, $22.50 for the third hour, and so on.

(3). Shortage of water, ice troubles, or in case of a steam station, shortage of coal, and similar causes.

Barring very exceptional cases, these causes may be considered under the control of the power company, and to be avoided by reasonable foresight and diligence. Contracts should not be taken for the supply of more power than is justified by low-water records for ten years or more, ice troubles can be guarded against by competent engineering and sufficient capital expenditure, shortage of coal can be guarded against by providing adequate storage and using foresight and prudence.

The customer should be protected against interruption and loss from such causes, and they might well be specially named in the contract.

(4). Undue Preference.—It sometimes occurs that a power company will favor one customer to the detriment of others. For the purpose of financing an enterprise advance contracts are frequently made at low rates and subsequently other contracts are obtained at more remunerative prices. When it comes, then, to a shortage of power obtainable from the plant as a whole or a shortage due to part of the machinery being "laid off," or to great pressure from a customer having a "pull," or to a question of supplying additional power under the terms of a contract made at low rates, this undue preference is liable to affect the customer, and any customer is entitled to liberal protection against such a contingency

(5). Diminution of the Supply.—It may be considered that variations in the voltage and frequency of supply are equivalent to a diminution in the supply, for such variations, if at all frequent or lasting an appreciable time, may cause more actual loss to the customer by affecting the quantity and quality of his output than an occasional total interruption. Most contracts contain stipulations on this point, but few, if any, specify any penalty for breach, and this being a matter decidedly under control of the power company, the customer should have, and should see that he secures, adequate protection in this matter.

Variations of voltage and frequency were discussed in the previous article of this series.

Summing up the principal points discussed above, it is suggested that the penalty clause should cover:—

(1). Intentional stoppage for necessary repairs, etc., involving a moderate penalty if the stoppage overlaps with the hours when supply is needed.

(2). Unforeseen breakdown, when a moderate penalty is justified, and it is suggested that this might be on a sliding scale depending on the length of interruption.

(3). Interruptions due to shortage of water, or coal, ice troubles, etc., which it is suggested should be specially named in the contract and provided for.

(4). Undue preference by the power company.

(5). "Diminution," due to irregular voltage and frequency.

The last three points are those which, in the opinion of the writer, are most frequently the cause of trouble and loss to the power user, and those on which he should be most fully protected in the contract.

It also appears advisable, though it is not usually done, to embody a clause providing that an interruption lasting more than a certain time, or interruptions occurring with more than stated frequency shall be sufficient cause for the customer to cancel the contract. This leaves the customer an opportunity to change his arrangements if the contract is not satisfactorily carried out.

RAILWAY EXTENSIONS IN BRITISH COLUMBIA.

The announcement of the provincial government's railway policy is awaited with considerable interest. Now that people are coming into British Columbia there is urgent demand for means of transportation to and from the vast unopened districts, rich with resources and abundant with possibilities. The government has proceeded slowly to date with railway matters, but now that there is a demand for lines, it will very probably present a policy that will meet with approval. It will provide for railways on both Vancouver Island and the mainland. The line on Vancouver Island from Nanaimo to Alberni is in operation, and another extension of the Canadian Pacific Railway is proposed to the northern part of the island, which will give transportation facilities to the greater part of that vast undeveloped portion of the province.

The Canadian Northern's line to Barclay Sound provides for the southwestern part, and a line along the west coast north from Alberni, will complete a satisfactory system, though to make it thoroughly adequate some branches will be needed. There are large fishing and lumbering interests on the west coast, and a line will be of great service. The sea voyage is very rough and more than one staunch steamer has been lost on the stormy shores north of Cape Beale.

On the mainland, the biggest proposition is the line to the Peace River district, necessary if Vancouver is to retain the trade of the northern part of the province. Mr. A. G. McCandless, president of the Vancouver Board of Trade, has taken a special interest in this project, realizing how important it will be to this city and Victoria. He outlined the advantages of such a road before the board, and headed a delegation that went to Victoria to bring the matter to the attention of Premier McBride and his colleagues. The reply of the Premier was significant. He stated that the policy of his government contemplated a line through the territory mentioned.

Not only will such a line of railway be the means of the coast cities reaching the Peace River district country direct, but it will open a great extent of country, which now has entry only by trail. True, the Cariboo road runs north from

Ashcroft to Fort George, and has served a good purpose. A railway though, will enable settlers to take up land in the Pemberton and Lillooet valleys, be the means of developing the timber and mineral areas, and will tap a district north of the upper reaches of the Fraser that are now practically unknown. Vancouver wants the construction of the Peace River line.

North Vancouver will be greatly benefited by the extension of the Canadian Pacific Railway around the head of Burrard Inlet into the city on the north shore of Burrard Inlet. Plans have been filed at the registry office in New Westminster for such a line. It will not be very long, but will give North Vancouver direct railway connection, something it does not yet possess. Little thought has been given to the Canadian Pacific Railway in the matter of railway facilities for North Vancouver, and the proposed route is one of the simplest in reaching that city. It was to bring railways to the north shore that the bridge across the second narrows of Burrard Inlet was proposed, the construction of which is almost assured. It was concluded that with a suitable bridge over the inlet, the Vancouver, Western and Yukon, which holds a charter for construction to the north, would cross the inlet from its Great Northern connection, and probably go farther north.

The contract has been let for the construction of a plant for the Portland Cement Construction Company, a branch of the Associated Portland Cement Companies of London. This will be the second plant on Tod Inlet, Vancouver Island, and will be directly opposite the operating works of the Vancouver Portland Cement Company, established eight or ten years ago, and of which Mr. R. P. Butchart is general manager. The new plant will be one of a series to be constructed by the Portland Cement Construction Company across Canada, and the approximate cost is placed at $1,000,000. The contract has been awarded to the McAlpine, Robertson Construction Company, which has offices in Vancouver, and which is a branch of Robert McAlpine & Sons, of Glasgow and London.

Doubling of its power supply is the improvement already under way by the British Columbia Electric Railway Company. The company has a large plant on the north arm of Burrard Inlet, and it is proposed to construct another tunnel to Lake Buntzen and duplicate its generating plant on the shore of the inlet. It is proposed also to increase the output of its auxiliary steam plant from 12,000 to 20,000 horsepower. This will give 105,000 horsepower, and the work will involve the expenditure of approximately $1,000,000. An effort will be made to complete the work at the end of the present year. Three Doble waterwheels, with a capacity of 14,000 horsepower each, will be needed and the contract for these has been let to the John McDougall Caledonian Iron Works Company, Limited, of Montreal. The generators will be manufactured by Messrs. Dick, Kerr & Company, London. This work will be the largest development enterprise in hand for the present in the province.

WORLD'S CONSUMPTION OF BUNKER COAL.

The suggestion that the opening of the Panama Canal may render feasible the establishment of a great American station for supplying coal from the mines of the United States to vessels of the world lends interest to an estimate prepared by the Bureau of Statistics, Department of Commerce and Labor, of the coal consumption on the oceans of the world. The statement estimates the coal consumed on the oceans of the world at approximately 75 million tons per annum, valued at over 250 million dollars.

An exact statement of the quantity of coal consumed by the merchant marine and navies of the world cannot be made, owing to the fact that comparatively few countries state the quantity of coal supplied to vessels for their own use, or for "bunkering" purposes. The United States statistics show about 9 million long tons supplied to vessels at ocean ports to be placed in their bunkers for their own use, and the British reports show about 20 million long tons supplied to vessels in the foreign trade and 2½ million tons to vessels in the coastwise trade. This would make for the two great coal producing countries of the world—the United States and the United Kingdom—a total of over 30 million tons supplied directly to vessels for "bunkering" purposes. In addition to this, however, a very considerable percentage of the coal sent out of Great Britain as "exports" passes to ports and stations in various parts of the world from which it is finally supplied to ocean vessels for fuel purposes. A paper presented before the Royal Statistical Society of England by D. A. Thomas, M.P., stated that:

"The great bulk of our export of coal is for the use of steamships, and it is within the mark to say that over half of our exports are for navigation purposes. . . .Cardiff alone ships over a million tons annually to Port Said, over a half million to Malta and Gibraltar, about the same quantity to Cape Verde and the Canaries, over 300,000 to Colombo, and large quantities to Aden, practically the whole of which goes to bunker steam vessels calling to coal at these depots."

As the British exports of coal, aside from that recorded as supplied to vessels for fueling purposes amounted in 1910 to over 62 million long tons, the above quoted estimate would seem to justify adding to the 30 million tons recorded as bunker coal by the United Kingdom and the United States another 30 million as the share of British exports which finally becomes bunker coal through purchase for bunkering purposes at ports or stations to which it was originally exported. While the Bureau of Statistics is unable to state the share of American coal exports which become vessel supplies (aside from that actually reported as bunker coal and not included in the export statement) it is quite probable that a considerable percentage of the coal from the United States which passes to the West Indian Islands and the coast of Mexico, is used for vessel fueling. Add to this the more than two million tons supplied by the Japanese mines to vessels engaged in the foreign trade, the more than 1 million tons supplied from Australia, the nearly 1 million tons supplied from India, plus the estimated consumption of about 3 million tons by the navies of the world, and the Bureau of Statistics estimate of an average of 75 million tons consumed on the oceans of the world seem a conservative one.

The United States is by far the largest coal producer of the world, its production in 1910 being 441½ million metric tons, against 264½ million by the United Kingdom, 222 million by Germany, 39 million each by France and Austria-Hungary, 24½ million by Russia, 23 million by Belgium, 15 million by Japan, 14½ million by China, 13 million by Canada, and 12 each by Australian and India, the grand total of production in 1910 for all countries for which statistics are available being a little over 1 billion tons, of which about 40 per cent. is produced by the United States, about 23 per cent. by the United Kingdom, and about 20 per cent. by Germany.

The coal beds of the United States contain large quantities of coal especially suited to steamship use by reason of steaming qualities, freedom from danger of spontaneous combustion, and proximity to the seaboard. Canada will figure higher in the list in due time, and the opening of the Panama Canal should assist that end.

LOSS OF HEAD IN THE FLOW OF AIR.

The following information on friction loss in the flow of air is abstracted from Catalogue No. 137 of the Green Fuel Economizer Co.:

Loss of Head by Friction of Air in Pipes.—Friction or resistance to the flow of air through a flue or conduit can be expressed as a negative head to be subtracted from the total head possessed by the air before passage through the pipe. The head lost in friction varies with the velocity, the roughness of the enclosing surface, curvature of the channel and the form of the cross-section; it also depends upon the viscosity, which varies with the temperature. Moreover, the drop in head follows at high velocities a law different from that holding for low velocities. That is, below the so-called critical velocity the drop is proportional to the velocity, while above the critical velocity it becomes proportional to the square of the velocity. In flues of ordinary cross-section and with the velocities common in fan practice, the flow is turbulent, that is, above the critical velocity. For this condition the following expression for loss of head due to frictional resistance may be used, namely,

$$Hf = U^2 \, Y \, L \, Z \div 2g \, Q,$$

in which Hf is head in feet of air, [2]U is the velocity in feet per second, g the acceleration of gravity (= 32.17), Y a coefficient of friction, L the length of the pipe in feet, Z the perimeter of the pipe in feet and Q the cross-section in square feet. Values of Y are given on the accompanying chart. This gives the head lost in friction only and is not to be confused with the total loss of head required to force air through the pipe, since the head required to give the fluid velocity through the pipe is ordinarily included in the latter. Also, it applies only to straight parts of the flue. Bends and obstructions in the pipe will cause additional losses of head.

$$Hb = \frac{U^2}{2g} (b_1 + b_2 + \text{etc.}),$$

wherein b equals 1.1 for right angled sharp corners.

0.3 for sharp angles of 135 degrees,

0.25 for a right angled bend of which the radius is equal to the diameter of the pipe.

0.15 for a right angled bend of which the radius is 2 to 4 times the diameter of the pipe,

0.07 for a right angled bend of which the radius is 5 to 6 times the diameter of the pipe,

Zero for bends of which the radius is more than 6 times the diameter of the pipe,

0.15 for a branch turning off at 135 degrees.

1.5 for a grill or register of which the free area is one-half the total area and the free area is equal to the cross-section of the pipe line,

0.75 when the area of the register is one and one-half times the cross-section of the pipe.

When the free area of the grill or register is 0.2 that of the total grill, b = 2 when the free area is equal to the area of the flue and 1.0 when it is equal to 1½ times the area of the flue.

For sudden changes in the cross-section of the flue, $b = [(Q_1 \div Q_2) - 1]^2$, in which Q_1 is the cross-section of the large pipe and Q_2 the cross-section of the small pipe and b is used in connection with the velocity in the large pipe.

Loss of Head Through Orifices, and Equivalent Orifices.—Since the head required to produce a given flow, S, of air through an orifice increases as the square of the flow, and since the head required to overcome the friction of bends, contractions and other obstructions in the air circuit also increases as the square of the flow, we may write the equation of the complete circuit as follows:

$$H = R \, S^2$$

wherein H is the total head required to force the volume S in cu. ft. per second through a circuit of which the total resistance is R. If R be expressed in appropriate units, 1 ft. head of air will produce a flow of 1 cu. ft. of air per second, through 1 unit of resistance.

Experiments made by W. N. Shaw indicate that such a unit or standard resistance would be that of an orifice in a thin plate of area a, where $a^2 = 1/27$ or a = 0.189 sq. ft. If the aperture is circular and of diameter d, then $(\pi d^2) \div 4 = 0.189$, or d = 0.498 ft. In other words, a circular aperture of a diameter of about 6 inches, will have unit resistance according to the above definition. Since the head consumed

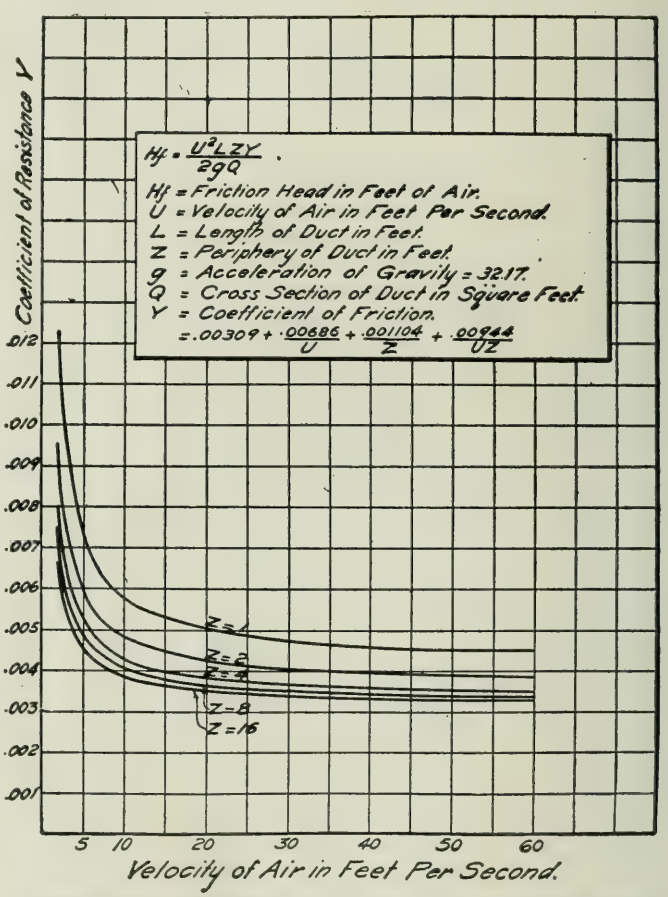


Chart Giving Coefficient of Friction Y for Smooth Sheet Iron Pipes.

by resistance increases as the square of the velocity of flow, it will further appear that the resistance of an orifice varies inversely as the square of the area of the orifice.

When different resistances are passed in series by the current of air, the total resistance of the circuit is the sum of the pneumatic resistances of the several parts arranged in series. For instance, suppose a room to have on one side an inlet orifice 6 in. diameter and on the opposite side an outlet orifice 1 ft. diameter. The resistance of the inlet orifice, according to the above definition, will be 1. The area of the outlet orifice is four times as great as that of the inlet orifice, and the resistance will therefore be 1/16 and the total resistance encountered in forcing the air into and out of the room will be 1 1/16.

[2] Head of feet of air may be converted into pounds per square foot by reference to Table I., and this to inches of water by multiplying by 12/62.4.

If air flows from one point to another by two different paths simultaneously, the drop in head over each path will be the same. If the resistances of the two paths are R_1 and R_2 respectively, we will have the equations

$$H = R_1 S_1^2$$
$$H = R_2 S_2^2 \text{ and}$$

also if the total flow is S we will have

$$H = R S^2$$

where R is the resistance equivalent to the combined resistances of the two circuits in parallel.

From these three equations we may easily deduce, since $S = S_1 + S_2$, the following:

$$(1 \div \sqrt{R}) = (1 \div \sqrt{R_1}) + (1 \div \sqrt{R_2})$$

Then if we substitute for R, R_1 and R_2 their equivalents, namely

$$\frac{1}{27a^2} \quad \frac{1}{27a_1^2} \text{ and } \frac{1}{27a_2}$$

where a, a_1 and a_2 are the respective areas of the equivalent orifices, we have $a = a_1 + a_2$, or in words, the combined air-passing capacity of orifices or channels in parallel is the same as that of a single channel whose equivalent thin plate orifice is equivalent in area to the sum of the areas of the equivalent thin plate orifices for the separate channels.

We may, therefore, speak of the thin plate orifice equivalent to the resistance of a mine, although the mine may contain many passages in parallel and series. Or we may speak of the equivalent orifice of a duct or a complex ventilating system, or the equivalent orifice corresponding to the grates, the fuel on the grates, the boiler passages and the chimney of a steam boiler plant. Or, if we know the equivalent orifices of the several parts which are arranged in series and in parallel, we can easily calculate the equivalent orifice of the whole.

Shaw's experiments are based on the use of a circular orifice in a thin plate, and a comparison of his formula,

$$H = \frac{1}{27\ a^2} \times S^2,$$

with the formula for falling bodies

$$U^2 = 2g\ H,$$

wherein g = acceleration of gravity and U = velocity in ft. per sec., will show that the coefficient of this thin plate orifice works out as 0.653. That is, only 65.3% as much air is passed through the orifice as would be passed if the whole orifice were occupied by a stream moving with the velocity U theoretically due to the head H. Orifices of different shapes and with different conditions of approach or efflux, have different coefficients. For instance, if the up-stream side be provided with a raised edge the coefficient will be reduced to about 0.5. If the collar is on the discharge side, however, and is extended to form in effect a long pipe, the coefficient will be increased to a value approaching 0.83.

Table I.—Total Weight of Saturated Air in Pounds Per Cubic Foot.

	Dry Bulb Temp., Deg. F.			
	30	40	50	60
Barometer.				
28.5	0.07703	0.07541	0.07381	0.07224
29.0	.07839	.07674	.07512	.07352
29.5	.07974	.07806	.07642	.07479
30.0	.08110	.07939	.07772	.07607
30.5	.08245	.08072	.07902	.07734
31.0	.08381	.08205	.08032	.07682
Additional for each degree wet bulb depression	.000017	.000019	.000022	.000026

	Dry Bulb Temp., Deg. F.			
	70	80	90	100
Barometer.				
28.5	0.07067	0.06909	0.06748	0.06581
29.0	.07267	.07032	.06868	.06700
29.5	.07317	.07155	.06989	.06818
30.0	.07442	.07277	.07109	.06937
30.5	.07568	.07400	.07230	.07055
31.0	.07693	.07523	.07351	.07174
Additional for each degree wet bulb depression	.000031	.000037	.000045	.000055

AN ACT TO CHECK THE SPREAD OF TYPHOID.

The following is the text of a bill now before the Senate, which is of interest to all engineers dealing with sanitary matters:—

1. The Criminal Code is hereby amended by inserting therein, immediately after section 222 thereof, the following sections:

"222a. Every one is guilty of an indictable offence, and liable to one year's imprisonment, who endangers the lives or health of the public by emptying or depositing any excreta, whether solid or liquid, from a typhoid fever patient.

(a) into, or on the banks of, or near to, any lake, pond, well, river, stream or other water, from which, either directly or at any place lower down in the waterflow therefrom, any city, town, or village is supplied with water for drinking or domestic purposes, or,

(b) into, or on the banks of, or near to, any water discharging into such lake, pond, well, river, stream or other water, or,

(c) into any water-closet, drain, ditch, conduit, or sewer so discharging, or,

(d) into any privy or cesspool, or,

(e) by making any other disposition of such excreta, except as hereinafter specified.

"222b. Every one is guilty of an indictable offence, and liable to one year's imprisonment, who,

(a) being a medical or other attendant upon any person, and knowing that person to have typhoid fever, fails or neglects to give notice immediately to the health-officer of, or to the mayor or other head officer of, the municipality in which that person is being attended, or was attended, that the person had typhoid fever; or,

(b) being such health officer, mayor or other head officer, and having received such notice, fails or neglects to make promptly effectual arrangements to have the excreta, both solid and fluid, of such person treated with carbolic acid or such other disinfectant as will effectually destroy all bacilli and germs therein, and to have the said excreta after they have been disinfected, buried in the earth at least three feet below the surface of the ground and at least three hundred yards from any lake, river, pond, stream, drain, ditch, conduit, sewer or other waterway."

2. Section 223 of the Criminal Code is hereby amended by substituting for the words "last preceding section" in the third line thereof, the words "three sections last preceding."

3. In every city, town, or other municipality wherein a case of typhoid fever occurs, or has occurred within one year next before the passing of this Act, this Act shall be published at least twelve times in a daily or weekly newspaper in or near the locality where such case occurred.

Metallurgical Comment

T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

MICROGRAPHIC EXAMINATION OF FAILURES.*

J. S. Glen Primrose, A.G.T.S.

The "Metallographic Examination of Engineering Materials" has been so enormously developed within recent years that it has given experts an extremely valuable insight into the internal structure of most alloys, of which iron and steel are the most important, and shows that in many cases the proximate composition, as revealed by the microscope, is of more importance than the chemical composition. Metallography has emerged from the stage of doubt and uncertainty in which it for a time existed, and has now attained a position of practical importance in no way secondary to physical testing or chemical analysis, so that practically every steel works of note possesses a photo-micrographic equipment, and many engineering shops are following suit. The engineer himself may not have the time available during his training to devote to a study of practical metallography, and, even in practice, be unable to perform a microscopical examination for himself; but he should at least have sufficient knowledge of the rudiments of the art, that he can comprehend the report and illustrations of an expert metallographist, and understand how it is possible to arrive at a fairly accurate idea of the life history of the materials with which he has to work, and also ascertain their fitness for any particular purpose.

The chief advantage of metallography over the ordinary methods of chemical analysis is that it is much more rapidly performed, and can deal with portions of metal much too small for analysis, and, further, it reveals the mode of arrangement of the constituents, whose presence only is detected by the analysis. Unlike the ordinary methods of mechanical testing, it can be carried out without destroying or even injuring the test-piece, which for micrographical purposes need not be detached from the work. The microscopical examination cannot only be done before putting the material into service, but it can also be applied in the case of a failure, and the metal right up to the place of fracture can be inspected

After pointing out the limitations of the art, the author described the most modern methods of work applied in a systematic metallographic examination, as also the latest forms of microscopes and the influence of using different methods of illuminating the carefully prepared and polished specimens or micro-sections. The chief micrographical constituents of iron and steel were copiously illustrated by a series of original micrographs, showing the effect of increasing carbon content, also that of mechanical and heat treatment on the structure, as shown by the various magnifications obtained with the metallurgical microscope.

Investigation of Failures.—The general method adopted in examining a case of failure was stated as first consisting in making a chemical analysis to determine faults due to incorrect composition or segregation of impurities. Static or dynamic tests follow to show up the defects arising from incorrect working of the material; and, as a final word, sections are examined microscopically to discover if wrong heat treatment or fatigue has been put upon the metal. Each method can afford independent evidence, but conclusions drawn from the combined results usually give the true solution.

FIG. 1.—Wrought-iron angle-bar, showing phosphide segregation in ferrite ground mass and black areas of slag. Magnification, 120 diameters.

FIG. 3.—Mild-steel plate, showing irregular arrangement of pearlite in the ferrite ground mass and two circular phosphide segregations. Magnification, 120 diameters.

FIG. 2.—Wrought iron, showing carbide inclusion as a dark band of pearlite in ferrite ground mass and black slag patches. Magnification, 60 diameters.

From the slides shown to illustrate some of the failures investigated by the lecturer photo-micrographs are reproduced on pages 748, 749, and 750. Fig. 1 shows the micrograph made from a portion of a wrought-iron angle-bar, the failure of which caused a serious boiler explosion, attended with fatal results. The actual fracture, which happened to be carefully preserved, showed quite a silky appearance, but a streak about ⅛ in. in from the bend, and parallel to it, exhibited quite a large crystalline structure much whiter than the remainder. The micro-section was taken across this, and shows in the figure quite a marked phosphide segregation running through the ferrite ground mass, and surrounding the elongated slag enclosures. As picric acid was employed in etching, the phosphide showed up highly colored in the actual specimen, although it only appears as a half-tone area in the reproduction. The quality of the metal was not inquired into at the subsequent inquiry, but the analysis give an average value of 0.34 per cent. of phosphorus, which was much too high, even apart from the embrittling manner in which it had segregated as phosphide. Clearly such metal should not have been employed in the position it was.

* Abstract of opening lecture delivered to the Glasgow University Engineering Society.

Another example of brittle wrought iron on investigation showed the fault to be due to the incomplete removal of the carbon, which did not appear unduly high on analysis, but the micro-section (Fig. 2) shows that the rolling had extended it into a flat plate, in which the carbon percentage would approximately be half of 1 per cent., and thus the tubes rolled from this material split, with disastrous results. The micrograph shows the central dark band of pearlite, and on either side the white ground-mass of ferrite with the slag extended longitudinally through it.

thus produced, there are two well-defined phosphide patches in the section, which, although colored in the sample, only show as dark circular stains in the ferrite. The section was taken from a portion of the plate close to the fracture, and the chemical analysis showed 0.14 per cent. of carbon and 0.08 per cent. of phosphorus.

A rail steel of medium-carbon content, which broke under the drop-test, showed the reason for failure very distinctly under the microscope, the micrograph being given in Fig. 4. This shows the much elon-

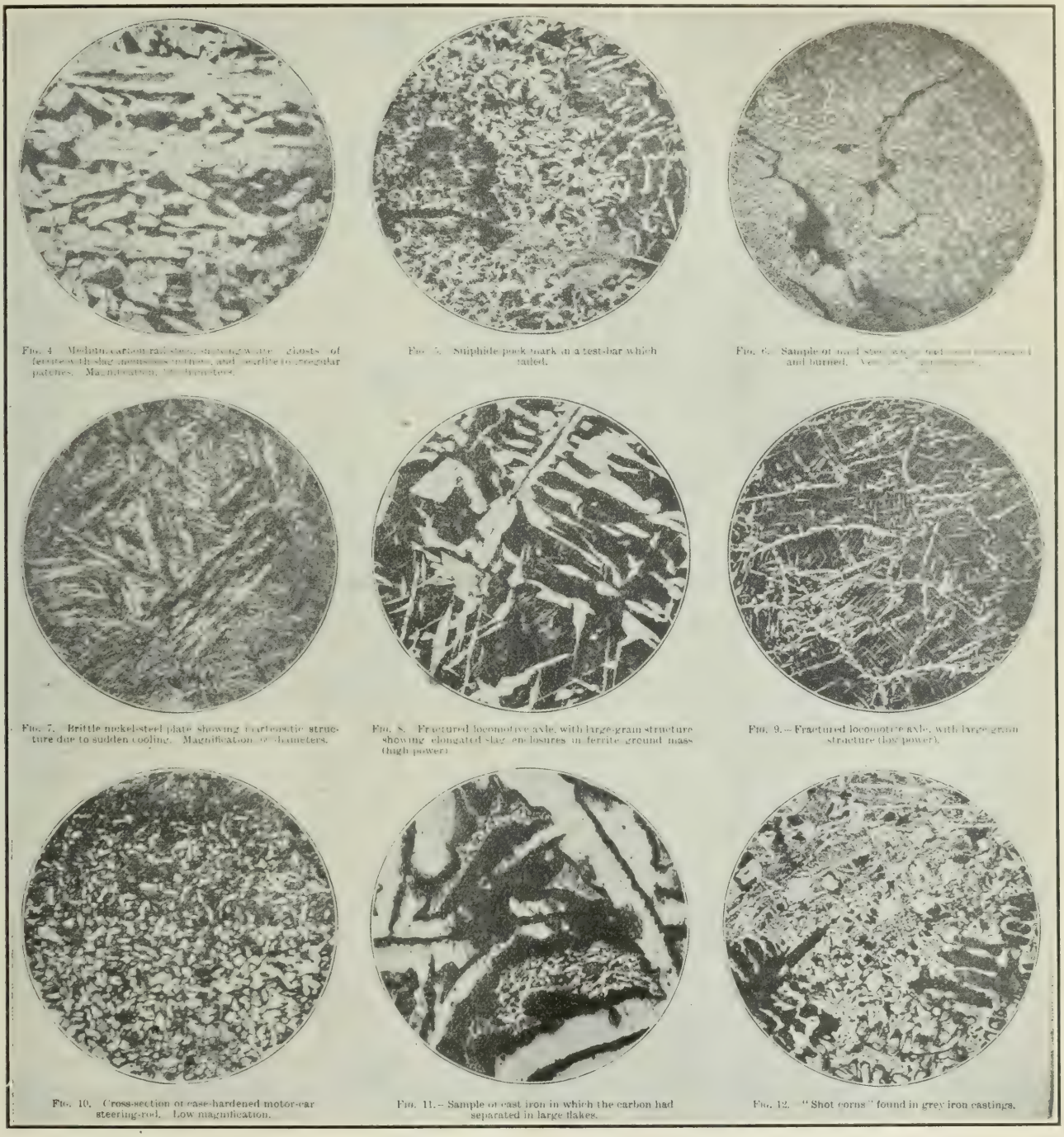


Fig. 4. Medium-carbon rail steel, showing white ghosts of ferrite with slag inclusions outlined, and pearlite in irregular patches. Magnification, 100 diameters.

Fig. 5. Sulphide pock-mark in a test-bar which failed.

Fig. 6. Sample of mild steel [illegible] and burned. [illegible]

Fig. 7. Brittle nickel-steel plate showing Widmanstätten structure due to sudden cooling. Magnification 100 diameters.

Fig. 8. Fractured locomotive axle, with large-grain structure showing elongated slag enclosures in ferrite ground mass (high power).

Fig. 9.—Fractured locomotive axle, with large-grain structure (low power).

Fig. 10. Cross-section of case-hardened motor-car steering-rod. Low magnification.

Fig. 11.—Sample of cast iron in which the carbon had separated in large flakes.

Fig. 12. "Shot corns" found in grey iron castings.

The micrograph reproduced in Fig. 3 was taken from a mild steel plate which fractured very badly on bending, although the test-piece had come up to specification tests. The structure shows a very elongated and irregular arrangement of the pearlite through the ferrite ground-mass, indicating that the metal had been finished at too high a temperature, and either not afterwards annealed, or annealed at too high a temperature. In addition to the brittle effect

gated bands of ferrite, free from carbon, and known as "ghosts," in which has been entangled quite a considerable amount of slag. This is seen to be grey in shade and quite distinct from the irregular pearlite areas, which under a higher power were seen to be well laminated (indicating that the metal had been left to cool slowly from an over-heated condition), and not sorbitic in character, as it would be in a properly-finished rail. The

carbon content was slightly low at 0.3 per cent., but the weakness was undoubtedly due to the structure being traversed by the weak ferrite bands, and also to the slag inclusions which increase the tendency for the metal to split along the "ghosts."

Failure is not commonly due to the presence of sulphur in the form of sulphide segregations, but when these occur the metal is found to be not only "red short," but also to develop brittleness when cold, and fail by fracture under even moderate stresses. Fig. 5 shows the micrograph of a sulphide "pock-mark" noticed in a test-bar which failed to come up to standard. The chemical analysis did not indicate any marked segregation, but close to those parts of the bar at which the skin had puckered in testing, the appearance was found to be very much altered, as seen in the lower part of the micrograph. In this portion both manganese and iron sulphides were recognized, and embedded with these in the ferrite were considerable masses of scoriaceous or slaggy matter.

A very general fault in annealing is to raise the temperature too much, and this gives rise to too large a crystal growth, readily recognizable under the microscope, and even in extreme cases to what is called "burning."

Fig. 6 shows the appearance under a very low power of a piece of over-heated mild steel which has also been "burned." The ferrite ground mass not only shows the large crystal structure and irregular distribution of the pearlite, but heat cracks have made their way into the mass from the edge of the billet and left the characteristic track of oxide film, showing up as a black inclusion. Whilst for over-heating the remedy is proper annealing and rolling or forging, for the defect of "burning" produced in this way there is no remedy, short of remelting the material, if the oxide films have penetrated to any considerable depth.

A somewhat unusual type of brittleness was shown by a consignment of nickel-steel plates, which were unfortunately scrapped before the micrographic examination was made. Along one edge the plates were almost glass-hard, and had considerably damaged the shears employed to cut them. The carbon content was only 0.33 per cent., so that the structure under normal conditions should have been pearlitic; but Fig. 7, under a high power, shows the appearance, which is a strongly martensitic or triangular structure. This brittleness could only have arisen by a drastic quenching, and inquiry elicited the fact that some of the plates, whilst on the cooling bank, had been exposed to the action of a heavy snowfall, which sudden cooling was practically equivalent to quenching. This defect could therefore have been easily rectified by a suitable annealing.

One of the most interesting cases of failure investigated by the author was that of a locomotive axle which fractured while the engine was travelling at express speed, but fortunately without serious result. In the summing up of the inquiry blame was largely thrown upon the design of the built-up axle, and yet the two micrographs reproduced in Figs. 8 and 9 clearly show that the metal was in itself distinctly faulty, even although it has passed specification tests. The chemical analysis gave the carbon content as 0.43 per cent., and the sulphur and phosphorus were well within the limit; but on testing the material for tensile strength it broke at an ultimate stress of 30½ tons per sq. in., and gave an extension of only 6¼ per cent. on the 3-in. test-piece, which was the largest size available. The low-power micrograph (Fig. 9) indicates from the large size of the grain structure that the metal had been left after manufacture in a brittle or overheated condition, possibly due to incomplete mechanical working, or the finishing of this at too high a temperature. The strongly marked lattice-work arrangement of the ferrite around and through the pearlite is characteristic of brittle and untrustworthy material. The higher magnification (Fig. 8) shows a further source of weakness by reason of the presence of elongated slag enclosures in the ferrite ground mass, and both of these defects had evidently given rise to the conditions favorable to developing "fatigue" of the metal from which it finally fractured.

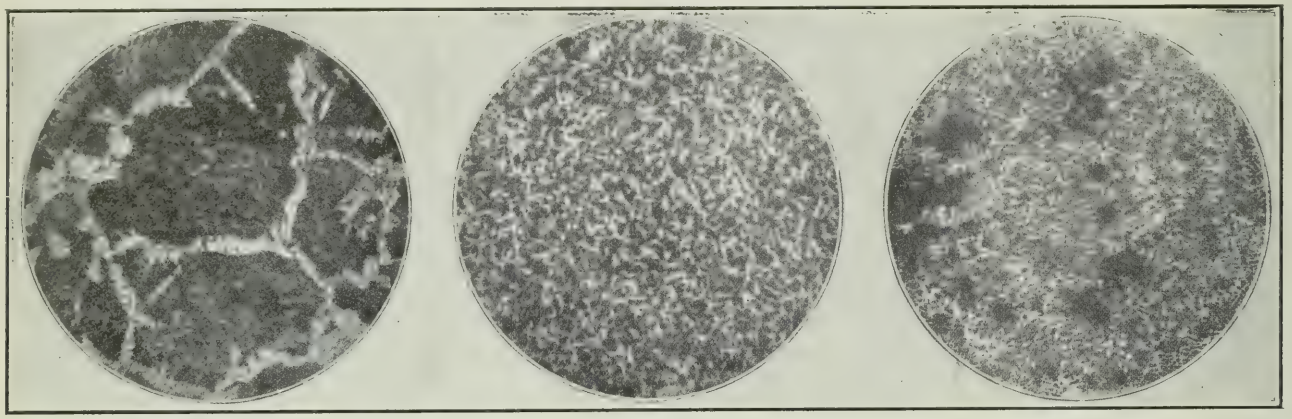


FIG 13.—Motor-car axle before annealing.

FIG. 14.—Motor-car axle after annealing and fairly rapid cooling.

FIG. 15.—Section of cast-iron water-pipe with blow-holes

Such metal could undoubtedly have been restored to a proper condition by a suitable annealing and fairly rapid cooling before being put into use, and instances were quoted to show how motor-car axles which developed serious brittleness had been heated and oil-quenched to produce the necessary reduction in the grain size and uniform distribution of the pearlite to give exceedingly durable material (Figs. 13 and 14).

The failure of a motor-car steering-rod, due to fracture, was shown to be due to the imperfect case-hardening of the material. Fig. 10 shows the micrograph of a cross-section near the point of fracture, and shows, even at the low magnification, the very sharp line of demarcation between the martensitic structure of the outer edge (shown at the top) and the mild-steel centre containing the ferrite ground-mass with small quantities of pearlite. Evidently a small heat or surface crack had penetrated the hardened skin, which, not being well cemented to the core, had yielded under the stress of a sudden twist.

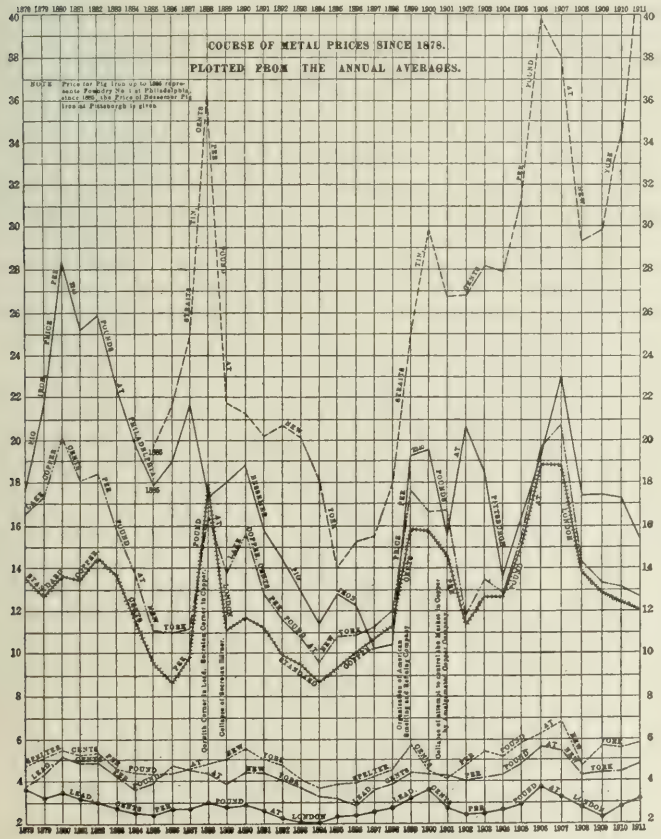
Cast iron is not usually called upon to withstand heavy stress put upon it, but hydraulic castings occasionally fail in a way which may appear mysterious without the aid of the microscope. One peculiar case of the failure of a heavy casting while in service was investigated, the test-bar having given entirely satisfactory results. It had cooled at a much

quicker rate than the metal in the casting, which was rather high in silicon for the thickness employed, with the result, as shown in Fig. 11, that the carbon separated in very large flakes, which were without doubt the cause of fracture. The metal was also weakened by the considerable degree of segregation of the iron phosphide, which appears as the eutectic mass enclosed within the dark pearlite areas.

Sometimes even grey iron castings fail on account of the separation within them, of minute "shot corns" or bullets of a very hard material, often attributed to chilled metal. In nearly every instance of such defects investigated by the author these were shown to be due rather to eutectiferous segregation of iron phosphide. These bullets are often much too small for analysis, but the microscope reveals the characteristic eutectic structure, as shown in Fig. 12, which not only illustrates the peculiar manner in which the pearlite areas are affected, but indicates how the iron phosphide can separate out in lozenge-shaped crystallites when above the eutectic proportion. This makes the portion of metal extremely hard and brittle to shock.

Blow-holes in castings are responsible for many failures, particularly in instances where the metal is desired as hard and close in the grain as possible. Fig. 15 illustrates the micro-structure of a water-pipe which failed badly under pressure, owing to the defective manner of casting, which had evidently produced too sudden a cooling. The ground mass had been converted into the cementite characteristic of a white iron, and the large amount of contraction had led to the formation of unsound patches in the interior of the metal, indicated by the dark holes scattered throughout the pearlite areas.

The lecturer claimed that there were many cases in which the microscopieal examination of metal before use would prove a great service to the engineer, particularly in preventing the use of faulty material unsuited for the purpose to which it was to be put.



ENGINEERING NOTES.

Ottawa, Ont.—The operation of the municipal electric light plant during the year 1911 was the best in the six years during which the plant has been owned by the city. A net profit of $27,716.37 is shown in the annual report. During the year $34,000 was spent on extensions to lines. The cost of constructing the white way, three miles in length, was $21,194. On the new conduit between the power house and the distributing station $38,505 was spent.

* * * *

Fredericton, N.B.—It is reported that Sir Thomas Tait, president of the Fredericton and Grand Lake Coal and Railway Company, has increased his holdings in the New Brunswick coal areas by the purchase of 112 acres of coal property.

* * * *

Montreal, P.Q.—The plans of the Harbor Board include the extension of Alexandra and King Edward Piers, the construction of a new pier to be known as No. 1. Two lift bridges, with railway and roadway accommodation, will be flung across the basin to the Guard Pier, where 1,600 feet of new wharf is to be built, thus materially increasing the accommodation of the port.

The construction of islets or anchorage banks in the Laprairie Basin, to hold the ice until melted in the spring.

The construction of grain elevator No. 2, and jetty at Section 19, with conveyors reaching adjacent piers.

The improvement and extension of the Harbor railway tracks from Victoria Pier to the Racine Wharf above winter water level, so as to be useful both summer and winter.

Completion of Victoria Pier and Market Basin, giving 2,700 lineal feet of high level quays for ocean steamers, with a depth of 35 feet at low water, and 4,000 lineal feet at low level quays for river vessels.

The erection of permanent sheds on the new Victoria high level quays, including equipment.

The lengthening of the Alexandra and King Edward Piers to about 1,200 feet each, and of the Jacques Cartier Pier to 1,100 feet, and a corresponding lengthening of the sheds upon them.

PERSONAL.

Mr. Charles Brandeis, C.E., of Montreal, has been appointed consulting engineer to the Saraguay Electric & Water Company, in place of his previous appointment, as chief engineer.

Messrs. Mitchell, Wilson and Holloway have been selected by Mr. L. E. Cousins to assist in the engineering work of the Harbor Board. These gentlemen were employed in the city engineer's department of Toronto.

Mr. J. P. Gordon has been appointed assistant chief engineer of the Hudson Bay railway. Mr. Gordon has been in the employ of the Hudson Bay railway two years in the capacity of locating engineer. Prior to this connection he held various engineering positions with several roads. His work has been entirely restricted to Western Canada. He held the position of locating engineer with the Great Northern railway in British Columbia for five years. Prior to that he was for about five years resident engineer with the Canadian Northern railway on the Prince Albert, Saskatchewan and Edmonton branches.

ENGINEERS' CLUB OF TORONTO.

The elections of the Engineers' Club resulted in the following gentlemen being appointed directors: Messrs. L. E. Cousins, A. J. Van Nostrand, A. L. McAllister, James McEvoy and George Powell. The election of the new officers will take place in the near future.

The statement prepared at the close of December, 1911, showed a membership of 423, of which there were 2 life members, 317 resident members, 70 non-resident, and 34 associate.

COMING MEETINGS.

CANADIAN FORESTRY ASSOCIATION.—February 7th and 8th, 1912. Forestry Convention Meetings held in the Railway Committee Room, Parliament Buildings, Ottawa. Secretary, Mr. James Lawler, Canadian Bldg., Ottawa.

CANADIAN LUMBERMEN'S ASSOCIATION.—February 6, 7 and 8, 1912. Annual Meeting to be held at the same time and place as the Canadian Forestry Association.

THE ENGINEERS' CLUB OF TORONTO, 90-96 King St. West.—Meeting, Thursday, Feb. 8th, 8 p.m. (in Lecture Room) of Canadian Section of Society of Chemical Industry. Address by Mr. F. N. Speller, Metallurgical Engineer, National Tube Co., Pittsburg, Pa., on "The Manufacture of Soft Steel Tubes in Relation to Corrosion." R. B. Wolsey, Secretary.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Tuesday evening, February 13, at eight-fifteen o'clock, in the Engineering Societies' Building, 29 West 39th St., New York, the American Institute of Mining Engineers co-operating. A paper entitled "Notes on Design and Mechanical Features of the California Gold Dredge" will be presented by Robert E. Cranston, consulting engineer for the Marysville Dredging Co., Marigold, Cal.

THE CLEVELAND ENGINEERING SOCIETY.—Regular Meeting, Tuesday Evening, February 13, 1912, Chamber of Commerce Bldg., Cleveland, O. Address by Mortimer E. Cooley, Dean, Department of Engineering, University of Michigan; Subject: "Public Utilities and Their Relation to the Public." Secretary, F. W. Ballard.

THE ENGINEERS' CLUB OF TORONTO, 90-96 King St. West.—Thursday, Feb. 15th. Dinner at 6-30; Lecture at 8 p.m., in Dining Room. After dinner address by Prof. W. R. Lang, Major Canadian Engineers, "Organization, Administration, Duties and Achievements of the Engineering Forces of the Crown," illustrated with models and lantern slides of Bridges constructed by the Royal Engineers in different parts of the Empire. R. B. Wolsey, Secretary.

CANADIAN NATIONAL ASSOCIATION OF BUILDERS.—The Sixth Annual Convention will be held in Toronto, February 20, 1912.

ONTARIO GOOD ROADS ASSOCIATION.—Annual Convention to be held at Toronto, February 26, 27, 28. Secretary, J. E. Farewell, Whitby.

THE ENGINEERS' CLUB OF TORONTO, 90-96 King St. West.—Thursday, Feb. 29th, 8 p.m. Meeting of Toronto Branch of Canadian Society of Civil Engineers. R. B. Wolsey, Secretary.

THE CANADIAN MINING INSTITUTE.—Annual meeting held in Toronto, March 6th, 7th and 8th, 1912, the American Institute of Mining Engineers co-operating; also important delegates of the Institute of Mining and Metallurgy of Great Britain will be present. Secretary, H. Mortimer-Lamb

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—**President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.**

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready City Clerk, **Fredericton.**

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—**President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.**

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—**President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.**

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—**President, N. McMurchy; Secretary, Mr. McClung, Regina.**

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—**President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.**

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—**President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.**

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—**President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.**

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—**President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.**

CANADIAN FORESTRY ASSOCIATION.—**President, Thomas Southworth, Toronto; Secretary, James Lawler, Canadian Building, Ottawa.**

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; **Secretary-Treasurer, Francis** Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—**Windsor Hotel, Montreal. Pres**ident, Dr. Frank D. Adams, McGill University, Montreal; Secretary. H Mortimer-Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—**President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.**

CANADIAN SOCIETY OF FOREST ENGINEERS.—**President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.**

CENTRAL RAILWAY AND ENGINEERING CLUB.—**Toronto, Pres**ident, G. Baldwin; Secretary, C. L. Worth, 409 **Union Station. Meets third Tuesday each month except June, July, August.**

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—**President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.**

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—**President, W. B. McPherson; Corresponding Secretary, A. McQueen.**

ENGINEERS' CLUB OF MONTREAL.—**Secretary, C. M. Strange, 8 Beaver Hall Square, Montreal.**

ENGINEERS' CLUB OF TORONTO.—**96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.**

INSTITUTION OF ELECTRICAL ENGINEERS.—**President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.**

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—**Secretary, R. C. Harris, City Hall, Toronto.**

MANITOBA LAND SURVEYORS.—**President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.**

NOVA SCOTIA MINING SOCIETY.—**President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.**

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—**President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.**

ONTARIO LAND SURVEYORS' ASSOCIATION.—**President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.**

THE PEAT ASSOCIATION OF CANADA.—**Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.**

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—**President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.**

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—**Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.**

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—**President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.**

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

TENDERS PENDING

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page
Calgary, Alta., bridge	Feb. 10.	Jan. 18.	86
Calgary, Alta., sluice gates	Feb. 29.	Feb. 1.	68
Galt, Ont., Y.M.C.A. building	Feb. 24.	Feb. 1.	59
Hamilton, Ont., works supplies	Feb. 6.	Jan. 25.	59
Lajord, Sask., schoolhouse	Feb. 10.	Jan. 25.	59
Little Lameque, N.B., wharf	Feb. 14.	Jan. 25.	59
Kerrisdale, B.C., valves, hydrants, etc.	Feb. 19.	Feb. 1.	59
Lake Quinze, Que., dams and sluiceways	Feb. 15.	Jan. 25.	59
Lloydminster, Sask., public building	Feb. 7.	Jan. 25	59
Lethbridge, Alta., extension to power house	Feb. 15.	Feb. 1.	59
London, Ont., engines and pumps	Feb. 14.	Feb. 1.	70
Meaford, Ont., construction work on E. Breakwater; dredging	Feb. 26.	Feb. 1.	59
Ottawa, Ont., launches	Feb. 24.	Feb. 1.	59
Ottawa, Ont., contracting machinery	Feb. 26.	Jan. 11.	59
Saskatoon, Sask., subway	Feb. 23.	Jan. 25.	68
Saskatoon, Sask., pavements	Feb. 16.	Jan. 18.	86
Saskatoon, Sask., concrete sidewalks	Feb. 16.	Jan. 18.	86
Swift Current, Sask., theatre	Feb. 16.	Jan. 25.	59
Toronto, Ont., track intersections, etc.	Feb. 20.	Jan. 25.	72
Toronto, Ont., bridges	Mar. 2.	Feb. 1.	59
Upper Salmon River, N.B., pier	Feb. 14.	Jan. 25.	59
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., pumping machinery	Mar. 1.	Jan. 25.	72
Winnipeg, Man., piers and abutments, Red River bridge	Feb. 14.	Feb. 1.	59
Winnipeg, Man., transformers and accessories	Feb. 8.	Feb. 1.	59

TENDERS.

Calgary, Alta.—Tenders will be received at the office of the Division Engineer, Calgary, until noon of February 18, 1912, for concrete substructures, excavation, etc., for overhead bridges and subway at Edmonton. Full particulars at Chief Engineer's Office, Edmonton; Asst. Engineer's office, Strathcona, and office of N. E. Brooks, Div. Eng., Calgary.

Edmonds, B.C.—Tenders will be received until March 11, 1912, for the supply of about 35 miles of steel pipes, varying in diameter from 3 to 10 inches, for the municipality of Burnaby Water Supply. W. Griffiths, Clerk Municipal Council. (See advt. elsewhere in Can. Eng.)

Moose Jaw, Sask.—Tenders will be received until February 12, 1912, for the erection of the Saskatchewan College and principal's residence, plans and specifications of which may be obtained at the office of R. G. Bunyard, architect, Room 6, Bank of Commerce Chambers, Moose Jaw.

Ottawa, Ont.—Tenders are invited for the construction of a quarantine station at Keremos, B.C., specifications of which may be obtained from Wm. Thompson, V.S., of Keremos, B.C. Tenders to reach Ottawa not later than March 1st, 1912. A. L. Jarvis, Asst. Deputy Minister and Secretary of Agriculture, Ottawa.

Ottawa, Ont.—Tenders will be received by the secretary Board of Control, City Hall, until February 13, 1912, for the supply of broken stone, brick, stone setts, cement, plank and cedar, sand, vitrified clay pipe, asphalt, castings, street sweeper's brooms, hardware, or street sprinkling wagons. Full particulars at office of Newton J. Ker, City Engineer, Ottawa. (See advt. elsewhere in Can. Eng.)

Ottawa, Ont.—Tenders will be received by the secretary of the Water Works Committee, until February 13, 1912, for the supply and delivery of brasswork, special pipe castings, hydrants, cast-iron pipe, lead pipe and pig lead, valves, oils and grease, as the case may be. Full particulars at the office of Newton J. Ker, City Engineer, Ottawa. (See advt. elsewhere in the Can. Eng.)

Ottawa, Ont.—Tenders will be received until February 20, 1912, for the construction of east and west highway approaches to the steel service bridge over the Red River at Lockport, Selkirk County, Man. Plans, specifications, etc., may be obtained at the offices of W. Z. Earle, Esq., Dist. Engineer, 504 Ashdown Block, Winnipeg, Man.; J. G. Sing, Esq., Dist. Engineer, Confederation Life Bldg., Toronto. Ont.; J. L. Michaud. Dist. Engineer, Merchants Bank Bldg., St. James St., Montreal, P.Q.; Postmaster at Lockport, Man., and R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the design and construction of a schooner for Pacific Coast Survey will be received until noon, February 15, 1912. Particulars with the officer in charge, H.M.C. Dockyard, Esquimalt, B.C. G. J. Desbarats, Deputy Minister the Naval Service, Dept. of Naval Service, Ottawa.

Ottawa, Ont.—Tenders for approximately 2,500 feet of 30-inch steel pipe in connection with the West End Drainage System, will be received by the Secretary of the Board of Control, City Hall, Ottawa, until February 15th, 1912, for the supply and laying same in the Ottawa River. Newton J. Ker, City Engineer. (See advt. elsewhere in Can. Eng.)

Toronto, Ont.—It is expected that the Northern Navigation Company will call for tenders in the near future for a 500-foot combined freight and passenger vessel. Mr. James Playfair, Midland, Ont., is president of this company.

Victoria, B.C.—Tenders for the erection and completion of a two-room frame schoolhouse at Port Alberni, in the Alberni Electoral District, B.C., will be received until February 14, 1912, by the Hon. the Minister of Public Works. Plans, etc., at the offices of A. D. Cooper, Secretary of School Board, Port Alberni, B.C.; the government agent, Alberni and Nanaimo; and office of J. E. Griffiths, Public Works Engineer, Dept. of Public Works, Victoria, B.C.

Victoria, B.C.—Bids for the supply of a new motor fire apparatus for the city of Victoria will be called for shortly. The new apparatus will consist of a combination motor hose and chemical wagon, an 80-gallon gas motor chemical and chassis for the present city service truck and engine at headquarters station.

COPIES OF ENGINEER WANTED.

A copy of our issue of March 30th, 1911, No. 13, is required. A month's subscription will be allowed to the party supplying this number.

Copies of the Canadian Engineer of the issue of January 18, 1912, are wanted. By forwarding same to the main office your subscription will be extended over another month.

CONTRACTS AWARDED.

Brantford, Ont.—Messrs. Schultz Bros. Company, Limited, have received the contract for the erection of a two-story schoolhouse on Chestnut Ave. The building will be comprised of basement, 84 x 112 feet, ten rooms, brick with reinforced concrete floors, concrete foundation, steam heating, electric lighting, etc.

Calgary, Alta.—Messrs. Nicholson & Bain, Winnipeg, wholesale commission merchants and brokers, have let a contract in Calgary for the erection of a six-storey solid brick warehouse and office building. It is also the intention of the firm to erect a large warehouse in Edmonton this year.

Carman, Man.—Tenders will be received until noon, February 17th, 1912, for the erection of two bridges over the Boyne River at Carman, Man. Plans and specifications for bridges may be seen at the office of the Manitoba Government Engineer at Winnipeg, Man., or at the office of A. Malcolmson, Secretary-Treasurer, Town of Carman, Man.

Edmonton, Alta.—The contract for the construction of the new municipal library has been let to William Ditz, local contractor, for $24,501.

Montreal, Que.—The contract for the erection of the new immigration buildings at Quebec has been awarded to Messrs. C. E. Deakin & Co., of Montreal. The sheds are to be erected by the government on the Louise Embankment. The new buildings are to be of steel and concrete, two stories high, over 700 feet in length, and will have accommodation sufficient for 1,500.

Montreal, Que.—The Canadian Pacific Railway Company have awarded a contract to Messrs. John S. Metcalf Co., Limited, Montreal and Chicago, for a reinforced concrete storage addition to their elevator at Port McNicholl, Ont. Capacity of additional storage will be 2,000,000 bushels, and estimated cost, together with additions to wharf work to enable travelling marine towers to reach new storage, is approximately $350,000.

New Westminster, B.C.—The contract for the construction of 6,900 feet of jetty at the mouth of the Fraser River has been awarded to Mr. T. F. Sinclair. Mr. Sinclair's tender of $171,000 was the lowest received, the Norton Griffiths Construction Company being second with a bid of $190,000. The other tenders received ranged up to $295,000 for the work.

Niagara Falls, Ont.—The contract for furnishing and installing the heating plant in the city hall has been awarded to J. T. Henderson, of this city, for $1,255. Three bids were received, the highest being $1,292.

Strathcona, Alta.—The Heenan-Frowde Co. have received the contract for the erection of an incinerator, at a cost of $40,200.

Toronto, Ont.—Tenders will be received until February 27th, 1912, for the construction of Toronto Junction Main Sewer, Section No. 4, Bloor St. Tunnel. G. R. Geary (Mayor), Chairman of the Board of Control, City Hall, Toronto. (See adv. elsewhere in the Can. Eng.)

Vancouver, B.C.—The contract for the supply of three large water turbines of 14,000 h.p. each, in connection with the power development of the B. C. Electric Railway, to be placed in a separate generating station on the North Arm of Burrard Inlet, has been awarded to the John McDougall Caledonian Iron Works Company, Limited, of Montreal; and the contract for the electrical generators, each of 9,000 k.w. capacity, has been given to Messrs. Dick, Kerr & Co., of London, England.

Vancouver, B.C.—The Grand Trunk Pacific has placed an order for 10,000,000 feet of lumber, mostly heavy timbers, bridge materials, etc., with the Victoria Lumber Manufacturing Company, of Chemainus, B.C. Lumber to be delivered in Manitoba to be used for construction east of Winnipeg.

NILE BRIDGE CONTRACT.

The tender of a Darlington (England) firm, the Cleveland Bridge and Engineering Company, has been accepted for the construction of a bridge to replace the Pont des Anglais over the branch of the Nile at Cairo known as the Bahr el Aama.

RAILWAYS—STEAM AND ELECTRIC.

Collingwood, Ont.—A report states that the Canadian Pacific Railway are preparing plans for an entry to this port.

Fort William, Ont.—Although there was a profit shown on the operating expenses of the street railway of over $55,000 in 1911, there was actually a loss of about $10,000 on that concern. Mayor Ray stated that the profit made on the street cars would not be sufficient to pay interest and sinking fund by $10,000, and therefore what was apparently a profit of $55,000, was actually a loss of $10,000.

Guelph, Ont.—A report states that the electric road to be built from Toronto to Guelph will go through Acton. Construction is likely to start this spring, but so far the plans of entry into Gelph have not been submitted to the Guelph city council for their approval.

Kingston, Ont.—The Canadian Pacific Railway intends shortly to take over and operate the Kingston and Pembroke Railway, and make extensive improvements.

London, Ont.—The management of the Lake Erie Coal Company have approached the municipal council of London with a view of electrifying the line of the London and Port Stanley Railroad.

Montreal P.Q.—Plans for the alteration of the C.P.R. bridge over Mountain street have been approved by the controllers. In connection with the laying of new tracks it will be necessary to widen the bridge, which already covers in a good part of the street between Dorchester and St. Antoine streets.

Montreal, P.Q.—A report states that the Montreal and Southern Counties Railway Company have under consideration the extension of its lines to Laprairie, Boucherville and Sorel, also having made an arrangement for the electrification and operation of the Montreal & Province Line Railway between St. Lambert and St. Cesaire, intending to extend the line from St. Cesaire to Granby, thereby giving the shortest route between Granby and Montreal.

Nanaimo, B.C.—The city of Nanaimo has given notice of its intention to apply to the legislature for authority to construct a railway from Nanaimo to Brecken, thence to Northfield, to East Wellington, through the Five Acre Lots to Extension, and thence to Nanaimo river bridge.

Ottawa, Ont.—The railway companies of Canada are taking steps to stop the practice of carrying explosives in baggage checked in the usual way and in packages of household furniture shipped as freight.

Port Colborne, Ont.—The Grand Trunk Railway will increase their yard accommodation at Port Colborne, and have leased from the Dominion Government all the government land lying between the Grand Trunk Welland line and Welland street.

Province of New Brunswick.—A third surveying party is to be started on work on the St. John Valley Railway.

LIGHT, HEAT AND POWER.

Montreal, P.Q.—Some weeks ago the Isle Au Heron Development Company filed with the Dominion Government a plan for the development of power at Isle Au Heron, practically opposite the Lachine power site. The drawings submitted show two parallel walls, between which a part of the flow of the river is intended to go and at the end is a concrete dam. The Hon. F. D. Monk announced that nothing, as regards approval of the company's plan or authorization of its undertaking, will be done until the Departmental engineers or the commission on St. Lawrence water power schemes reports fully in the matter.

Montreal, P.Q.—It is stated that the Cedar Rapids Manufacturing & Power Company will call tenders for the dyke and power house without much delay, as it is the desire of the company to begin active operations at the plant in the early spring. Mr. Henry Holgate, C.E., Montreal, is provisional president.

Ottawa, Ont.—A deputation from the Canadian Peat Society, assisted by a committee from the board of trade, will ask the minister of mines to have one or more engineers of his department sent to investigate and report on the

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leading peat, gas power installations in Europe. Messrs. G. B. Greene, A. W. Fleck and John McKinley will represent the board.

Ottawa, Ont.—An additional 200 horse-power for the municipal electric plant will be ordered from the Ottawa and Hull Power Company. The order is to date from December 1st last. This will make 3,100 horse-power taken by the city for the plant. The cost is $15 per horse-power, making a total of $46,500.

Prince Rupert, B.C.—The newly formed council have decided to push the hydro-electric work with all possible speed. This work includes the construction of a large concrete dam and the installation of a steel or cast-iron pipe.

Regina, Alta.—The Leader Publishing Company are installing a private power plant and water system in their new building. The company have placed with the British-Canadian Engineering and Supply Company, of Winnipeg, an order for a 100-h.p. Ruston Proctor engine and gas producer plant, together with a 75-k.w. Westinghouse generator. The plant will be utilized at times for pumping water from the well which has been sunk in the basement of the building, and which will furnish a water supply independent of that furnished by the city.

Saskatoon, Sask.—The city commissioners have decided that the wiring for the new lighting standards shall be of armored insulated wire. This will do away with conduits as the wire is buried in a trench. This does away with the difficulty often experienced in handling wires for repair purposes when they are in conduits.

Smith's Falls, Ont.—The Smith's Falls Electric Light and Power Company have installed a new auxiliary steam power plant of the most modern type. The engine is one of the largest of its kind in Canada.

Toronto, Ont.—It is reported that the municipal engineering department will recommend that a water meter be placed in every house and a yearly inspection of mains be made.

Vancouver, B.C.—The engineers at work on the trunk sewers have announced the possibility of tenders being called within the next few days for the construction of work.

GARBAGE, SEWAGE AND WATER.

Brantford, Ont.—During January at the waterworks 86,308,275 gallons of water were pumped as against 75,244,066 gallons in 1911.

Ottawa, Ont.—A sand filtration plant to cost about $2,000,000 has been decided upon by the civic water committee. The municipal engineer, Mr. Ker, has been instructed to make the necessary surveys, etc., and to procure any assistance required. The plant is to be erected on Lemieux Island and the intakes will receive their supply from the river, the present source of supply.

New Westminster, B.C.—The city engineer, Mr. I. W. Blackman, has recommended that a new reservoir be constructed with a storage capacity of 5,000,000 gallons, also the extension of the present reservoir.

Port Colborne, Ont.—The Canadian Union Furnace Co. will put in its own waterworks plant and fire protection. If the town so desires the municipal system can be connected up with the company's system, and in case of a big fire or other necessity the company's supply will be at the disposal of the town.

Toronto, Ont.—The estimates of the property commissioner for 1912 include the following items:—Scavenging, $267,875; pound, $450; street cleaning, $65,774; culvert cleaning, $12,467; asphalt cleaning, $156,420; street watering, $8,006; street flushing, $23,361; road oil, $25,000; stable, $59,592; plant and shop, $32,542; horses, $10,500; crematory, $12,700; water, $237; rental, $1,550; inspectors' salaries, $4,800; total, $681,274.

Town of Edmonds, Burnaby, B.C.—Authority has been given the engineers to substitute six-inch for four-inch water pipes and to complete specifications and call for tenders for a supply of pipe to be laid under the 1912 waterworks by-law.

Toronto, Ont.—The experts advising the city of Toronto upon its water problem suggested in their report that a 25,000,000-gallon steam pump be added to the equipment at the main pumping station. The city engineer will bring the matter before the council.

Toronto, Ont.—The city engineer, Mr. Rust, advised the council to clean out the reservoir annually for at least two or three years, when it is hoped that the use of filtered water will render it unnecessary after that time for some years.

Victoria, B.C.—The municipal council have appointed a committee to investigate certain defects in Smith's Hill reservoir.

Victoria, B.C.—Since the first of the year the city health department has taken over the handling of street sweepings, and in consequence the quantity of refuse handled by the garbage collectors has materially increased, the amount now being daily handled aggregating some 150 loads or well over 100 tons.

Winnipeg, Man.—A committee to investigate the disposal of garbage and sewage may be formed.

BUILDINGS AND INDUSTRIAL WORKS.

Brantford, Ont.—The directors of the Brantford Roofing Company have decided to increase the plant during the coming year. At the annual meeting the directors recommended the increase of the machinery to double its present capacity, the installing of an entire new system and the addition of two new stills capable of turning out from 1,200 to 1,500 additional rolls of roofing daily.

Burnaby, B.C.—The construction of a wharf on the North Arm of the Fraser and the erection of a new stone crushing plant at an approximate cost of $12,000, are a part of the plans of the municipality of Burnaby for the year 1912.

Calgary, Alta.—The Dominion Government have decided to erect a new customs building. The building will be five stories in height and will extend the full size of the lot, 175 x 160 feet. The cost will be at least $300,000. A government architect will plan the building.

Calgary, Alta.—Announcement is made that Wood, Vallance & Adams, of Hamilton, Ont., wholesale hardware, have decided to locate a branch in this city. The firm will erect a four-storey building.

Galt, Ont.—A syndicate of Toronto and Galt financiers have formed a brick manufacturing company. The output will be 40,000 per day.

Kingston, Ont.—It is reported that the Grand Trunk Railway propose building a new passenger station in conjunction with proposed new freight sheds on the site of the hay market.

Kingston, Ont.—Proposed additions to the Canadian Locomotive Works are planned. Additional stories will be built to the present buildings, and a couple of new buildings will be started. The company contemplates spending $1,000,000 in improvements.

London, Ont.—The following is the statistical building report for the city:—

	No. of Permits.	Estimated Value.
January, 1911	27	$ 7,030.00
January, 1912	13	18,717.00

Moose Jaw, Sask.—The Prairie Oil Company, Winnipeg, Messrs. F. H. Rees & Company and Benjamin Olsen are negotiating with the municipal council regarding the erection of factories, etc.

Montreal, P.Q.—The Westmount Methodist Church will probably erect a new building at the corner of Roslyn Avenue and Sherbrooke Street. The Rev. W. E. Baker, pastor.

Niagara Falls, Ont.—The Urschel Bates Valve Bag Company of Toledo, Ohio, with branch factories in nearly all of the large cities in the United States, will install a branch at this point. The new factory will occupy what is known as the old mill property. Messrs. Hartman and Motler are representing the company.

Saskatoon, Sask.—Mr. Meyer J. Sturm, of Chicago, Ill., has been requested by the City Council to prepare plans for the new civic hospital.

St. John, N.B.—There is a probability that a pig-iron industry may be established at this point. A mining company at present is shipping ore to points in the United States. The increased bounties, at present engaging the attention of the government, will, it is claimed, enable them to smelt the iron at a profit in Canada. The question which is now engaging their attention is whether it would be cheaper to erect blast furnaces at the mines where the shipping facilities would be limited or bring it to this port.

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Bulletin 110

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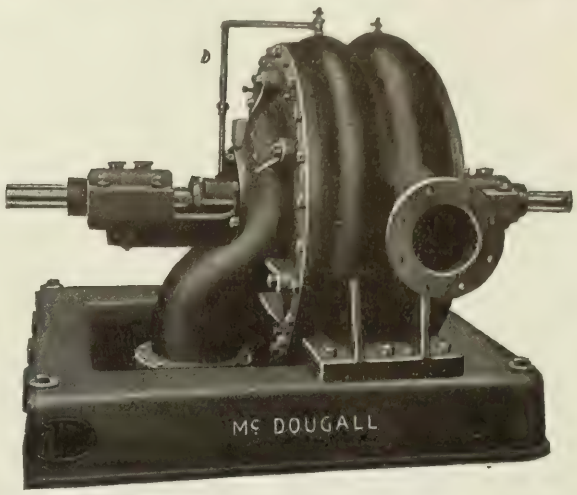

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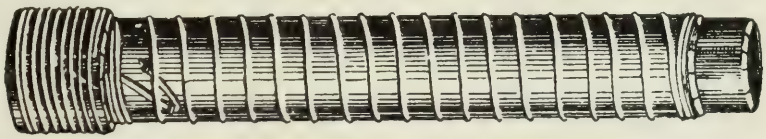

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Tilbury, Ont.—The Dominion Canners have issued instructions to the local management to proceed with the erection of a big addition to the local plant. The addition will be 180 by 40 feet.

Tod Inlet, B.C.—A report states that a local syndicate has completed all preliminaries toward the erection of a tourist hotel on Tod Inlet. Mr. Thos. Hooper, Victoria, B.C., architect, is drawing plans for the structure, which will have upwards of two hundred rooms.

Toronto, Ont.—The Confederation Life Association has secured a permit to build a one-story brick and steel addition to their Victoria street building, to cost $10,000.

Victoria, B.C.—Mr. H. S. Griffiths, architect, is preparing plans for an eight-story office building for the Dominion Trust Company, which will be erected on the corner of Fort and Douglas Streets.

Winnipeg, Man.—The T. Eaton Company has decided to square the present building and make a complete nine-floor structure with a frontage of 266 feet on Portage Avenue by 315 feet on Donald Street. There will also be installed five new passenger elevators and several freight elevators, two of the latter being so designed that they will carry either the delivery vans or loaded drays to the furniture floors where the loading and unloading will be done. Mr. H. McGee, vice-president, is considering estimates, etc.

Welland, Ont.—The plans of the Dominion Canning Company's plant to be erected in Fonthill, near Welland, have been issued. The main building will be three stories high, and will be used for canning tomatoes and fruit. It is expected that another large building will be put up in which corn and peas will be canned.

Winnipeg, Man.—An effort is being put forth by the members of the Anglican Church to build a cathedral near the centre of the city. It is the intention to have all the details sufficiently advanced to submit to the next meeting of the Synod in June.

BRIDGES, ROADS AND PAVEMENTS.

Kerrisdale, Point Grey, B.C.—This municipality is seeking government aid in the construction of a bridge across the deep ravine leading to the university site. It is estimated the bridge will cost in the neighborhood of $120,000.

Nelson, B.C.—A delegation waited upon the provincial government for the purpose of urging that body to construct a bridge across the Kootenay River.

Province of Ontario.—Experiments in treating clay roads with a solution of tannic acid will be conducted by Mr. W. A. McLean, provincial engineer of highways, during the coming spring and summer. This treatment will give a hardened surface to clay, rendering it tough and rubbery.

Welland County, Ont.—A report states that the good roads bill has received the official approval of the government, and will now be acted upon by the council.

York County, Ont.—Forty miles of macadam highway are to be constructed in this county. Mr. Ed. James, engineer. Tender will be found in this week's issue.

York County, Ont.—The York Highway Commission has deputed Messrs. J. J. Ward and George Henry to Ottawa with delegations from the Good Roads' Association, to wait on the Government on February 8, to ask for federal aid in the improvement of roads.

FIRES.

Halifax, N.S.—The Woodside plant of the Acadia Sugar Refining Company was totally destroyed by fire with a loss of over a million dollars.

Woodstock, Ont.—Fire damaged the Queen's and Victoria Hotels and stables to the extent of $20,000.

CURRENT NEWS.

St. John, N.B.—The Dominion Government are considering the contract for the harbor improvements at St. John, involving an expenditure of about nine million dollars. A company headed by Norton Griffiths, M.P. (Britain), is the lowest bidder in the tenders received by the late government.

Niagara Peninsula, Ont.—A report states an item for the construction of the new Welland Canal will be brought down in the House of Commons at an early date. The amount to be set aside for this work is to be $30,000,000.

Calgary, Alta.—Within the next few weeks Calgary will have one thousand new telephones in operation, and by the month of July, two thousand more will be available to customers.

Maritime Provinces.—A convention of delegates from every agricultural society, and every board of trade, the warden from each county, mayors, editors of newspapers, representatives from all farmers' and dairymen's associations, the Fruit Growers' Association, and representatives from the transportation companies, will be held in Fredericton at an early date, to discuss various means of increasing the trade of these provinces.

Winnipeg, Man.—Competitive plans for a new city hall for the city of Winnipeg will be called for shortly by the board of control.

Ottawa, Ont.—The municipal auditor is of the opinion that a purchasing agent be appointed for civic works.

LIVERPOOL DOCK EXTENSION.

The Mersey Docks and Harbor Board has decided upon a dock extension scheme, which will include a deep-water approach to accommodate vessels of 1,100 feet. The improvements, it is estimated will cost $15,000,000.

SOME RAILROAD CONSTRUCTION NOTES.

Probably the longest branch line, the Regina-Colonsay branch, of the Canadian Pacific Railway constructed last year was opened for traffic in November. The distance is 152 miles. From Regina to Colonsay it is 133 miles, while from Valeport, where the smaller branch leaves the large branch, to Bulyea, it is 19 miles. Another branch, from Outlook to Kerrobert, Saskatchewan, over 100 miles, is being constructed, and another from Weyburn and Macklin to Lethbridge. This line when completed will open a new route from Portland, Oregon, to St. Paul, Minneapolis and Chicago. From Swift Current, two branches of the Canadian Pacific Railway are being built and two branches from Wilkie.

The Canadian Northern Railway Company has spent over a million and a half dollars in improving its line between Regina and Prince Albert, a distance of about 250 miles. This line was originally known as the Qu'Appelle, Long Lake and Saskatchewan railroad, and was controlled by English capitalists and operated for many years by the Canadian Pacific Railway upon a lease which was taken over by Sir William Mackenzie when it expired in 1906.

In construction work on the Canadian Northern Railway 16,686 men are engaged. This road west of Port Arthur is operating at the present time 4,000 miles of railway. In addition, there is a line running from Fort Frances to Virginia, Minn., 98.9 miles long, controlled by the Canadian Northern. To the end of September last year 985 miles of track had been laid out of a total of 1,982 miles of new construction. It was expected that an additional 100 miles of track would be laid before the end of the year.

The Georgian Bay and Seaboard Railway of the Canadian Pacific Railway, from Victoria Harbor to Bethany Junction, Ont., was built during the year. Victoria Harbor is situated at the southerly end of the Georgian Bay, and Bethany Junction 14 miles west of Peterboro', on the present main line of the Canadian Pacific Railway, between Montreal and Toronto The length of the new line is 88 miles, 12 miles of which, from Victoria Harbor easterly to Coldwater, were completed in 1909. Work was started on the balance during the summer of 1910, and the line was opened for traffic late last year. The important towns passed through are Orillia and Lindsay. Extensive terminals are being constructed at Victoria Harbor, the yard tracks amounting in all to about 13 miles. A grain elevator has been constructed having a capacity of 2,000,000 bushels, accommodation being provided for five additional units of similar capacity.

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The same high-grade materials, the same skillful workmanship and the same years of experience that have built such famous service into the products of the Goodyear Tire & Rubber Co., U.S.A., is doing the same for Goodyear Rubber Belting and our many other rubber products.

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The highest grade made. Heaviest duck, best rubber, seamless, tough, durable. The saving main-drive belt for **Paper, Pulp** and **Lumber Mills**—for *all* mills where the horse-power transmitted is large and the demand for tensile strength is great.

Black Diamond Belting

Lighter in weight, lower in price than above, but same in *quality*. Great quantities sold to **Sawmill** trade. Hundreds of mill-owners say it gives better service than any other belt ever used.

Red Cross Belting

The ideal belt for **Thresher, Small Sawmill** and **Flour Mill** use. Built to meet competition, yet is far superior to all other third-grade belts because made of tougher rubber, heavier fabric (which means better friction) and better wearing service and cover.

Stitched Rubber Belting

We make this belting in **Quality, Black Diamond** and **Red Cross** weights for those preferring this type of belting.

Elevator Belts

We make a specialty of **Elevator Belts.** Our Leg and Lofter Belts used in hundreds of elevators. Give superior service because of greater strength. Buckets never pull out. Plies never separate. Long, efficient service guaranteed.

Conveyor Belts

For conveying crushed stone, grain, coal, ore, etc. Made in all thicknesses of face to suit requirements. Great toughness of rubber face prevents cutting and chipping; insures longest service.

IMPERIAL HIGH-SPEED FRICTION SURFACE BELT

Specially designed for planer, dynamo, generator or fan work where pulleys are small and high-speeded. If we haven't what you want in stock, we'll *make* it—and *remember*

Goodyear Rubber Belts quickly earn their cost in pains and power saved—yet they cost less than the common kind. Let our expert solve your problem. Send requirements or write for catalog to-night. In all of our business in Canada last year, we had to replace, because of slight defects, only $155.22 worth of goods.

19

The Goodyear Tire & Rubber Company of Canada, Limited

General Offices—Toronto **Factory—Bowmanville, Ont.**

Write our Nearest Branch

BRANCHES: Montreal — Winnipeg — St. John, N.B. — Vancouver — Calgary — Victoria, B.C., 855 Fort Street—Regina, Sask., 2317-2318 South Railway Street—Hamilton, Ont., 127 King Street West

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending January 22nd, 1912:—

A London firm of universal electrical providers and manufacturers who manufacture all classes of electrical fixtures, especially for the Canadian market, are desirous of getting into touch with actual importers in the Dominion.

A Derbyshire firm who supply large quantities of pulpstones to the Canadian market through United States agents, are anxious to get into direct communication with importers in Canada.

A London firm manufacturing a patent glass jar for preserving fruit and vegetables desire to get into touch with Canadian canners and others likely to be interested.

A firm in the English Midlands manufacturing cast-iron articles of all kinds covered with a porcelain enamel, and willing to conform to Canadian requirements, wish to hear from importers in the Dominion.

A Lancashire firm desire to find a market in Canada for Static transformers; also electric lifting tackle, such as hoist blocks, runways, light cranes, crabs, winches, etc.; and are prepared to appoint reliable agents in each province and each important business centre.

A Vancouver correspondent wishes to obtain United King goods, and construction material.

A Canadian firm of importers desire to secure the Canadian sales agency for specialties in paper manufactures such as D'Oyleys and table decorations.

A Toronto firm of grocery brokers desire to form a connection with a reliable London firm in a position to ship Ceylon and Indian teas in bulk; they are also in the market for supplies of cocoa beans and cocoa butter.

A Vancouver firm desire the agency of a United Kingdom manufacturer of cotton, cashmere, and woolen hosiery.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:—

A Yorkshire firm of baby carriage, toy, and steel folder manufacturers, operating several factories, desire a first-class representative in Montreal, having offices and showrooms, and possessing an established connection among stores, furnishers, etc.

A Yorkshire company manufacturing all types of steam boilers, chemical works, plant, tanks, pans, stills, heaters, etc., wish to extend their business to Canada.

A Liverpool company would be glad to receive offers from Canadian curers of dried codfish suitable for export to tropical countries.

A Montreal engineer is prepared to represent United Kingdom manufacturers of railway supplies and machinery. such as are used in connection with locomotives and rolling stock, and in railway shops.

THE BOARD OF RAILWAY COMMISSIONERS FOR CANADA.

Order No. 15819.

In the matter of the application of the Sanitaris, Limited, of Arnprior, in the Province of Ontario, for an Order directing Railway Companies to furnish, during cold weather, heated cars for the carriage of mineral water, ginger ale, and other bottled beverages, in quantities aggregating not less than carload lots, from one shipper to one or more consignees and destinations: File 18855.

Upon the hearing of the application on the 4th January last, and hearing what was alleged on behalf of the Railway Companies and the Applicant, and judgment being withheld for further information;

And upon its now appearing that Railway Companies had in practice systems of carrying way freight in heated cars; and upon the complaint of the Sudbury Brewing and Malting Company that such systems had been abandoned; and upon its appearing that at a meeting of the Canadian Freight Association, held on November 23rd, 1911, it is alleged in a circular sent to the said Brewing and Malting Company by the local freight agent of the Canadian Pacific Railway Company at Sudbury, that it was resolved that shipments in less than carload lots in heated cars should be discontinued; and its appearing that no notice of the withdrawal of such privilege had been given to shippers, and such withdrawal has worked hardship—

It is ordered that all railway companies subject to the jurisdiction of the Parliament of Canada shall forthwith reestablish the system or systems in practice by them of carrying less than carload lots in heated cars during the winter of 1910-1911; and shall forthwith grant to all shippers the rights and privileges of such shipping facilities in respect to such traffic as were in force upon their various lines during the said winter, until further Order, or until the reasonableness of the withdrawal of such facilities can be passed upon by the Board.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

15815—January 19—Extending until 1st March, 1912, time for execution of Commissions and for transmission to Secretary of Board at Ottawa in connection with examination of witnesses in Dawson Board of Trade vs. White Pass & Yukon Railway in connection with Order 15719, January 2nd 1912.

15816—January 17—Authorizing G.T.P.B.L.Co. to construct spur for Yellowhead Pass Coal & Coke Co., Ltd., Alberta; from its Mountain Park Coal Branch.

15817—January 18—Approving location of C.N.O.Ry. through Twps. of Springer, Field, Badgerow, Gibbons, and Crerar, District of Nipissing, mileage 366 to 386 from Montreal.

15818—January 18—Anuthorizing town of Leamington to cross with street right-of-way of M.C.R. (Leamington & St. Clair Branch).

15819—January 18—General Order re less than carload freight to be carried in heated cars, etc.

15820—January 20—Amending Order 15741, January 3rd, 1912, that "Applicant Company install cover plates their tracks pass through the sidewalk," C.P.R. spur Swift Canadian Co., Winnipeg, Man.

15821 January 19—Approving by-law of Maine Central Railroad Co., authorizing W. K. Sanderson, G.F.A., H. D. Waldron, G.F.A., and F. S. Davis, Chief of Tariff Bureau, to issue tariffs.

15822—January 18—Authorizing International Bridge and Terminal Co. to construct its bridge and railway across Church St., Fort Frances, Ont. Crossing to be protected by gates.

15823—January 19—Authorizing C.P.R. to construct its Lacombe Easterly Branch of C. & E. Ry.), across 10 highways, and divert same, to close up portions of diversions, mileage 129.47 to 139.22, Alberta.

15824—January 20—Authorizing Vancouver, Victoria & Eastern Ry. (G.N.R.) to construct portion of tram track on Front St., Vancouver, B.C.

15825—January 19—Approving location of G.T.P. Railway station at Fitzhugh, a divisional point in Alberta.

15826—January 22—Approving location of C.N.O.R. station grounds at Portland, Ont.

15827—January 20—Authorizing C.N.O.R. to cross public road on Lot 8, between Cons. 2 and 3, Twp. of Dorion, Dist. Thunder Bay, Ont.

15828—January 23—Authorizing Twp. of Brooke, Ont., to construct McDougall Drain under tracks of Canada Southern Rly. Co., (M.C.R.)

15829—January 23—Approving location of C.N.O.R. station grounds at Dwyer Hill, Ontario.

15830—January 24—Extending until 15th February, 1912, time for erection of gates by G.T.R. at John Street, Toronto, Ontario.

15831—January 24—Extending until June 30th, 1912, time for construction of subway over Elizabeth St., Toronto Junction, Ontario.

15832—January 24—Authorizing city of Strathcona to construct a level crossing over track of C. & E. Railway, (C.P.R.), at Third Ave., North.

15833—January 24—Authorizing C.P.R. to divert highway between sections 9 and 4, at Naples Station, mileage 85.3, Napinka, S.D.

15834-35-36—January 24—Dismissing applications of city of Strathcona, Alta., for level crossings over C. & E., (C.P.R.), at 2nd Ave., North, 2nd Ave., South, and 3rd Ave., South.

15837—January 25—Approving proposed addition of C.P.R. existing bridge and change of grade across Mountain St., Montreal.

15838—January 24—Authorizing G.T.R. to reconstruct swing bridge over Rideau Canal at Ottawa.

15839—January 24—Relieving G.T.R. from further protection at Adelaide Street, at Mount Bridges, Ontario.

15840—January 24—Authorizing Government of Province of B.C. to construct highway crossing over Shuswap and Okanagan Railway (C.P.R.), one mile north of Okanagan Landing.

15841-42—January 23—Authorizing C.N.O.R. to cross public road in Lot 8, between Cons. 1 and G., Twp. of Medora, Dist. of Muskoka, and across Jane Street, Twp. of York, County of York, Ont., by means of bridge carrying highway over railway.

15843—January 23—Extending until 9th April, 1912, time for installation of bell by C.P.R. two and one-half miles east of St. Basile, County of Portneuf, Quebec.

Volume 22. Toronto, February 15, 1912

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The Canadian Engineer

An Engineering Weekly

REINFORCED CONCRETE BRIDGES BUILT OVER CURRENT RIVER, IN THE CITY OF PORT ARTHUR, ONTARIO.

BY L. M. JONES.*

The city of Port Arthur is beautifully situated on a hilly slope rising from the waters of Thunder Bay, Lake Superior. Almost through the centre of the city winds a little stream known as McVicar's Creek, while towards the northerly end of the city Current River finds its way to the lake. The banks of these two streams, as well as the surroundings, abound in the beauty of Nature, and present a pleasing view to any who have spent some time in the neighborhood.

at this time was to give street car facilities to the employees of the Western Dry Dock and Shipbuilding Company's plant, which is located north of the river and near the lake shore.

Before commencing work there was considerable discussion as to where the bridges should be located, the Board of Park Commissioners being anxious to have the bridges built alongside the Canadian Pacific Railway Co.'s bridge, owing to the fact that they were of the opinion that the extension

Fig. 1.—View Showing Deck of Both Bridges, with Swimming Pool in Distance.

The spanning of these streams with traffic bridges, both for vehicles and electric railways, has given the city engineer's department an opportunity of designing bridges to suit the required conditions in each case.

In General.—The bridges to be herein described were completed in the year 1911, and are constructed within the city park system, the one spanning Current River, the other carrying traffic over the penstocks immediately north of the river. These bridges are on the line of Cumberland Street (the main street of the city) and upon which the lines of the Port Arthur and Fort William Electric Street Railway are constructed. The chief object of constructing the bridges

of the street railway would tend to divide the park into two portions. While this was somewhat true, the difficulties of construction, and the ultimate appearance of the bridges being considered, it was decided to build the bridge on the line of Cumberland Street.

The foundations at the location decided upon were solid rock, and as the work was done at the season of the year when the water was low, no difficulty was experienced in getting in the footings. For this location the type of construction selected was the reinforced girder and slab type, supported with concrete posts resting on the footings, with retaining walls to support the embankments. As there is a dam about 1,000 feet up stream from this location, it was decided that the placing of the posts in the river-bed would be

* City Engineer of Port Arthur, Ont.

all right, as there would be no ice, driftwood, or such like to contend with. In Fig. No. 2 will be seen a general elevation of the two bridges, with roadway connecting same. It will be noticed that there is a difference between the elevations of the roadways of the bridges. The reason for this is, that it was thought best not to set the roadway elevation of the longer bridge to suit the requirements of the bridge over the penstocks, as this would necessitate a long embankment of considerable height to approach the bridge from the southerly end, and, as stated before, objections were raised to having this roadway divide the park into two portions. Also, if the bridges were kept at the same level it would make the slopes of the earth embankment extend too far into the swimming pool, shown in Figure 1, on the left-hand

Fig. 2.—View Showing General Elevation of Bridges.

side. It is the intention to make the slope as built, rather flat, and sod it, so that children using the swimming pool can also use the slope to play on.

The difference in elevation of the bridges is 6.5 feet, and the grade of the roadway connecting them is six per cent., but as the distance is short there is no apparent difficulty in operating street cars over the grade.

The bridge over the river is made up of five spans, forty feet in the clear, there being five concrete posts in each bent, ten feet on centres, these posts being twenty inches square with champered corners and reinforced with four one-inch cup bars, held together with 3/16 in. hooping at intervals of one foot. The two outside beams were 16 in. by

Fig. 3.—Showing Exterior Features of Design.

36 in., and the three inside longitudinal beams being each 24 in. by 36 in., while the transverse beams over each bent were made 20 in. by 36 in. The minimum depth of the slab is nine inches, the roadway portion being sufficiently deep at the centre to form a suitable crown for the proper drainage of water, while the street railway portion was crowned to suit the depth of rail. The deck of the bridge is provided with two sidewalks, one being five feet wide, and the other six feet wide, a driveway 18 ft. 8 in. between the curbs, and a street railway reserve suitable for single track.

It might be well to explain here that owing to lack of funds, and the small amount of traffic in sight at the present time, we were unable to construct double tracks, unless the roadway width was sacrificed, which was not thought advisable. The vehicle roadway is paved with three-inch creosoted wood blocks laid in the usual manner, with expansion joints at each curb, and at every twenty feet at right angles to the line of the roadway. The portion in the track allowance was finished with 2 to 1 cement mortar troweled to a smooth finish with proper slopes to the rain water outlets.

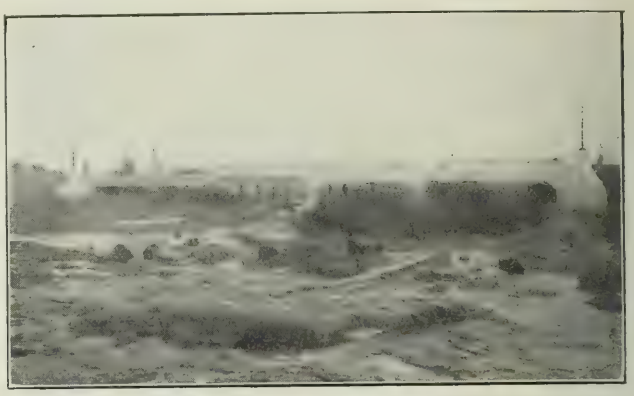


Fig. 4.—View Looking Downstream.

Overhanging the centre span on each side of the bridge was constructed a balcony 3 ft. 3 in. wide by the length of the span. These were built so that people could stand on them and view the falls above the bridge, and the scenery on the down-stream side, without interrupting the traffic on the sidewalks. The supports for these balconies were cantilevered from the main beam and covered with a slab four inches in depth. Besides providing space for sight-seers the balconies helped out in the aesthetic features of the design. The railing on the bridge is 2½-in. pipe with plain fittings, and a ball ornament on each post. Over each bent is constructed a concrete post, as part of the railing, while pedestals of larger proportions are placed at the ends of the railing to support the lamp standards. Where the pipe rails enter the concrete posts and pedestals they enter a

Fig. 5.—Bridge Over Penstocks.

pipe of large diameter set in the concrete, and in this way free ends are provided for expansion. The lamp standards are the "Luxolabra" type with five lamps on each, all lamps being 40 watt tungstens. The railing and lamp standards were all painted a deep green, and the effect is very good.

In designing the architectural features of the bridge the aim was to make all lines straight in preference to any

curved lines, and thus reduce the cost of formwork. Also, the idea being to make all surfaces as sharp and clean cut as possible.

The general features of the bridge over the penstock are similar to those of the longer bridge, the span being twenty-six feet in width. On the cross section of the bridge submitted herewith the details of the beams and slabs are fully shown. After the embankment connecting the two bridges has fully settled to a solid condition, it is the intention to connect the curbs, sidewalks, and railings on each bridge, and to finish the roadway in a permanent manner.

Cumberland Street Bridges; View of Form Work in Place.

The rails for the street cars were bedded and surrounded with concrete, being held together with tie rods at intervals of four feet. So far, and under traffic conditions, this has proved satisfactory, there being no signs of chipping or cracking of the concrete; in fact, this can be said of the entire work.

Design.—In figuring for the design of the bridges, the calculations were based on the following data:—

Live load, a thirty-ton street car, and an additional live load of one hundred pounds per square foot, with an amount for impact figured at fifty per cent. of the live load.

Ratio of modulus of elasticity of steel to that of concrete, 15.

Allowable working stress of steel in tension, 16,000 pounds per square inch.

Allowable working stress for concrete:—

(1). The extreme fibre, 750 pounds per square inch.

(2). Direct compression, 600 pounds per square inch.

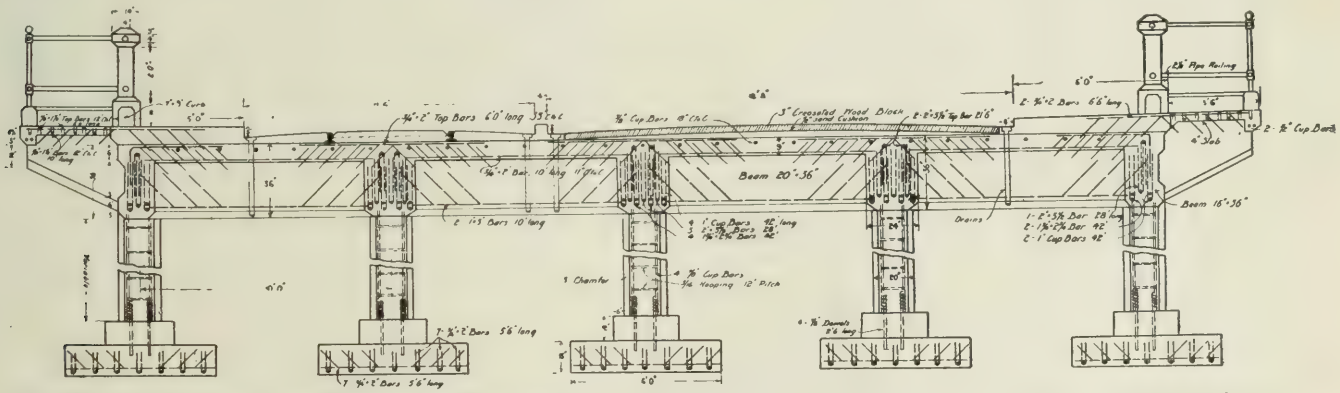
(3). Shear, 50 pounds per square inch.

Concrete.—The cement used in the concrete was Lehigh brand, Portland cement, which, when tested, had to meet the requirements of the cement specifications of the Canadian Society of Civil Engineers. The sand used was ordinary bank sand, sharp and coarse grained, with a very small percentage of loam. The broken stone called for in the specifications was crushed trap rock, of a size that would pass a one-inch ring. Shortly after the work was commenced the demand for crushed rock was so great that it was impossible for the contractor to secure any, so it was decided to use the lake shore gravel.

This gravel is found on the lake shore, about ninety miles from Port Arthur, and is admirably suited for work of this kind. In size the gravel ranges from the size of a pea up to that which will pass through a one-inch ring, the stones being of various shapes, mostly angular. As the surfaces of the stones are pitted, the cement mortar has a far better chance to bond with them than it has with ordinary gravel, and as the stone is of a granite nature the strength of the concrete was not feared by using this gravel. The proportions for the reinforced concrete were as follows: Columns, 1; 1½; 3. Slab, 1; 1½; 3. Beams, 1; 2, and 4, and for the mass concrete in wing walls and abutments, 1; 3; 5; with "plums" placed in the ordinary method. All the concrete was mixed with a "Ransome" concrete mixer. In order to obtain a good surface on the exposed faces of the bridge, the concrete mixture was of a sloppy nature, great care being taken to have the concrete well spaded and worked next to the forms. The results are very good, as may be seen in the accompanying views of the bridge.

Tenders were called for the work on July 10th, 1910, and the contract awarded to Messrs. Seaman and Penniman, of Fort William, on August 2nd. Owing to delays in securing materials the work was slow in progressing, so that it was late in the fall before the concrete work for both bridges was completed. All the forms were left on the bridge through the winter, and early in the spring of 1911 the wood blocks were laid, railing set up, and the bridges properly finished. The contractors are deserving of great praise for the work they did, their methods of working, and the diligent manner in which they attended to all the details of the form work, etc., had a good deal to do with the successful carrying out of the designs.

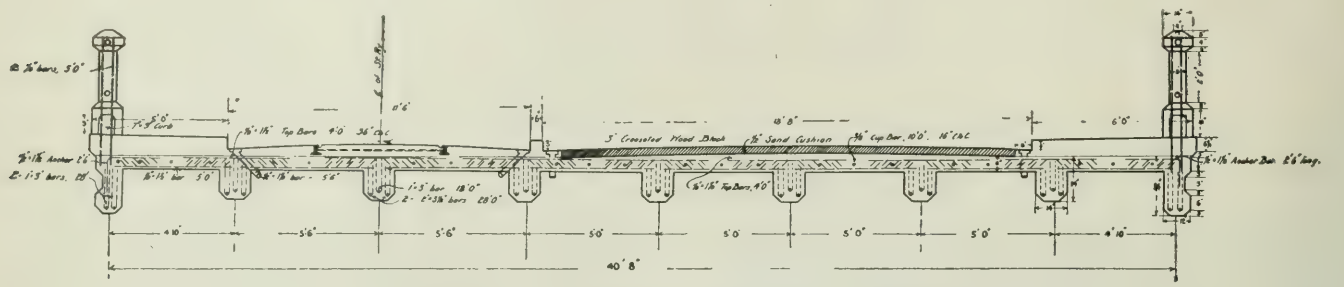
Construction.—The reinforcing steel used in the construction of the bridges was the "Kahn System of Reinforcing," and was furnished by the Trussed Concrete Steel Co., of Walkerville, Ontario. In order that contractors could tender on the same basis, as regards the reinforcing steel, the city purchased it direct and delivered it f.o.b. the site of works.



Reinforced Concrete Girder Bridge over Current River, Port Arthur. Section at Centre Span, Showing Balcony.

After the footings were set in place, the form work was commenced on the columns, girders, and abutments. The steel in the columns was then set in place, and the abutments and columns were poured to the level of the under side of girders. The forming was then constructed for the

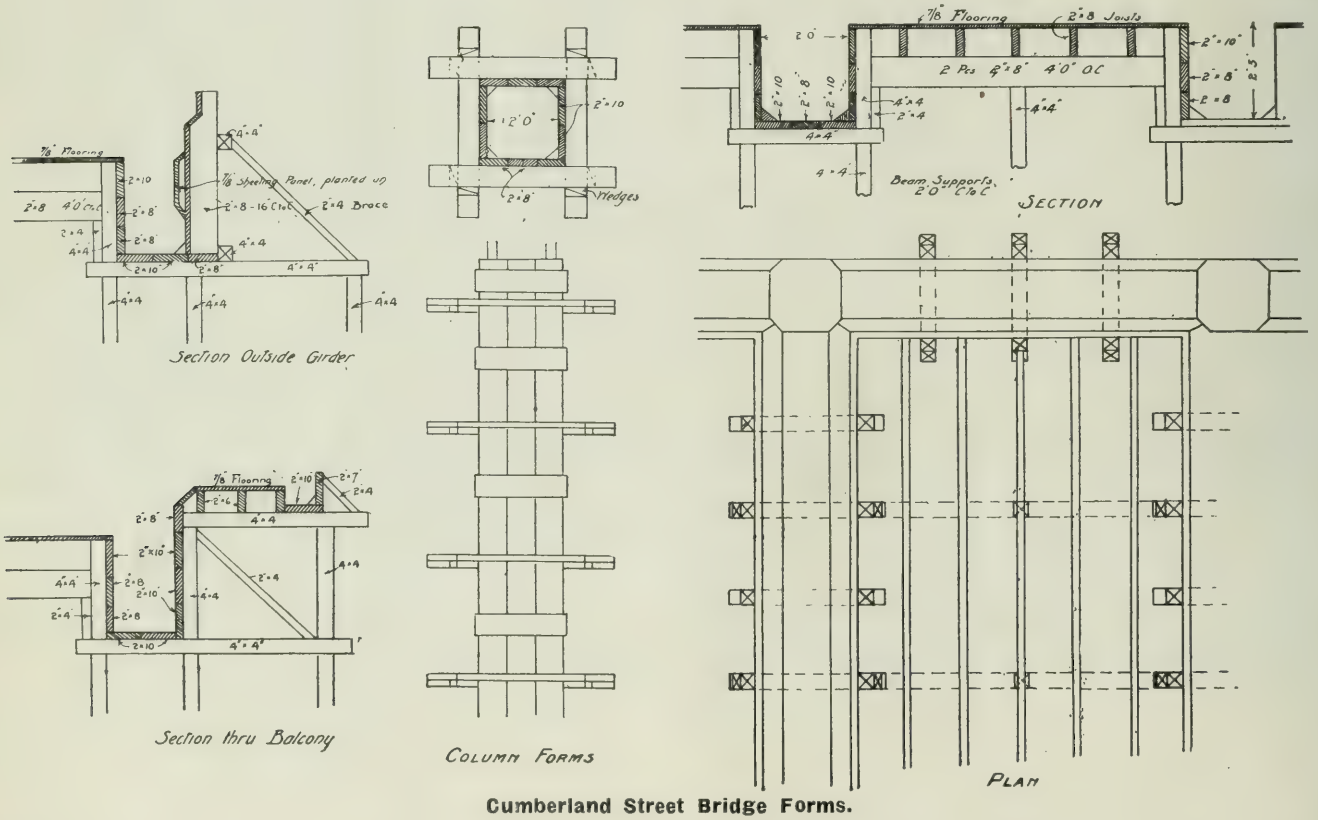
entire work on both bridges, according to the details shown in the plans presented herewith. Great care was exercised in getting the forms well braced and finished, so that all exposed surfaces would appear smooth and uniform after the removal of the forms. In this, the efforts were very successful, and good results were obtained. The forms for the long span girders were given a camber of ¾ inch at the centre of the span, to allow for any possible settlement when forms were loaded with concrete. After the work of setting forms was completed, the steel was placed in the girders, being firmly supported with wire, fastened to a 2-in. by 4-in. placed across the opening of girder forms at intervals of 3'–0. The pouring of concrete was then commenced and carried on day and night until the completion of each bridge. As stated before, the concrete was of a rather sloppy nature, and besides reasons previously stated, this was necessary as owing to the amount of steel in the beams, it was difficult to thoroughly embed it with anything but a concrete of this kind. The concrete work was commenced at one end of the bridge and finished up to the top of the slab, and continued in this way until the other end was reached, the steel in the slab, etc., being placed as the work progressed. A groove about 1½ inches in depth was left to set curb, anchors being set in this groove to further secure the curb. The curb and concrete posts were set after the concrete work on the sidewalks, roadway, and track portions was completed. Upon the completion of the whole work on the bridges, and after the forms were removed, the surfaces of concrete exposed to view were well brushed with steel brooms, and a coat of waterproofing, known as "Dry Wall" was applied. The results of the application are apparently all right, as far as can be seen at present, but it was feared at the time it was applied that the material would peel off.



Cross-Section of Concrete Bridges over Penstocks.

The cost of the bridges is as follows:—

Bridges, proper constructed in place	$17,589.98
Reinforcing steel	3,800.00
Freight and hauling steel	628.46
Lamps, including duty, wiring, etc.	585.85
Dry rock excavation	50.00
Boulder excavation	280.00
Dry earth excavation	153.40
Wet earth excavation	377.60
Rip-rap	198.20
Earth embankment	2,493.25
Sundries	223.94
Total	$26,380.68



Cumberland Street Bridge Forms.

These bridges were designed by the writer, subject to the approval of Mr. J. Antonisen, who was Commissioner of Utilities for Port Arthur at that time, while the construction of the bridges was in charge of Mr. C. E. Henderson.

SIGNALING AND INTERLOCKING.*

The author of this paper directed the attention of his audience to the signaling and interlocking systems of the new passenger terminal of the Chicago and North Western Railway Company.

When this structure had assumed a condition wherein the signaling system demanded a rigid comparison with pre-existing types, the three-position upper quadrant semaphore signal was adopted.

By the adoption of this type of signaling and the use of all three positions on the dwarf signals in the Lake Street or terminal plant, the company were able, with one signal, to give information of proceed, stop, and as to position of the signal ahead. This was deemed necessary for enginemen and trainmen in the safe handling of trains at reasonable speed, and results have shown the absolute safety and reliability of the practice. At Lake Street use was made of the third position on the last signals governing trains inbound into the depot to indicate that the track under the train shed is clear.

The dwarf signals (Fig. 1) are motor driven and, except at the Lake Street plant, all dwarf signals are used in two positions only, viz., horizontal and diagonal.

Inasmuch as the signaling and interlocking of a large terminal is installed as much for the acceleration of traffic as for its protection, the means of receiving and giving information and of communication is one of the important features, and was, therefore, given a great deal of attention, and in the solution of the problem almost everything was considered. The telegraph was dismissed from considera-

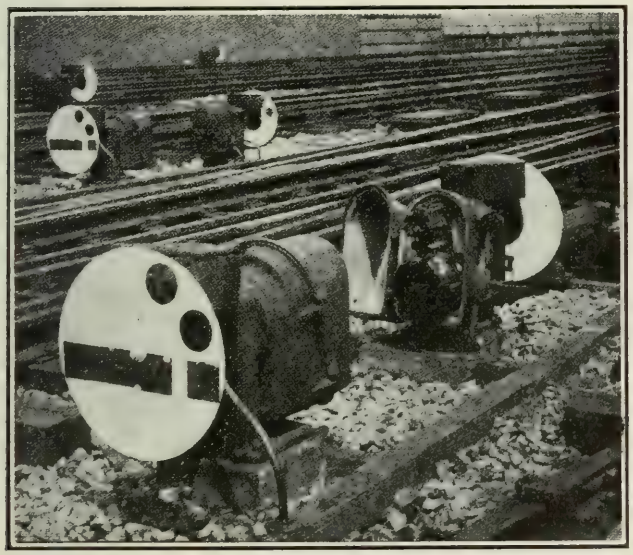


Fig. 1.

tion almost immediately, as it restricted too closely the source of supply for levermen to operate the plants and for tower directors. The various means finally adopted and used were:—

Conductors-towermen-gatemen's system of annunciators.

Telautographs.

Various forms of automatic train annunciators and indicators.

Illuminated track diagram.

Lights over levers.

Telephones.

Intercommunicating system.

* Abstracted from a paper read before the Western Society of Engineers, by J. A. Peabody.

In operating the system for through trains, the conductor pushes his butten one minute before time for his train to leave. This lights the top light on the tower director's table and the first light of the gatemen's indicators, reminding the tower director and gateman that it is nearly time for the train to leave. The tower director, if he can handle the train on time, immediately pushes his button, which action puts out the top light and lights the second one on his table, puts out the first and lights the second one at the gate, and lights the top light of the conductors' indicators. When it is time for the train to leave, the gateman closes his gates, and after waiting for the last passenger who went through the gate to get on the train or at least giving him sufficient time to do so, he pushes his button. This puts out the second light at the gate, puts out the top light and lights the lower one of the conductors' lights, and

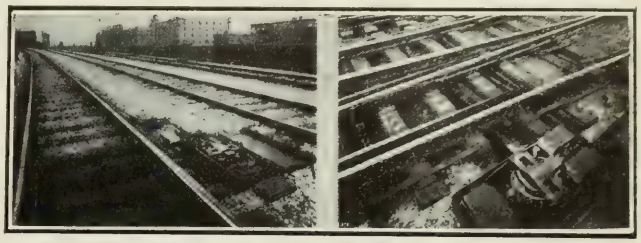


Fig. 2a. **Single Switch.**

Fig. 2b. **Double Slip Switch.**

puts out the second and lights the third of the tower directors' lights, thus advising the conductor and tower director that the train may leave. The conductor then, and not until then, gives the engineman the signal to proceed, which he does, provided the proper interlocking signal indicates that he may. The restoring of the first interlocking signal to the stop position automatically restores the system to its normal condition ready for the next move.

For giving information from one tower to another of a train move and something as to its character, a push button scheme was developed which has been named the "Intercommunicating System."

The indication on these boards is made by small telephone lamps arranged in horizontal rows and columns. The columns represent the track numbers, and the rows the various classification of trains. The boards were made to suit local conditions and are entirely of standard telephone apparatus.

The method of connecting the switch movements to the switches, movable point frogs, and derails is clearly shown in Fig. 2 a. b. The General Railway Signal Company's standard No. 4 movement was used for everything except derails, for which their standard No. 2 movement was used.

No detector bars were employed on the switches, derails, etc., of the Lake and Clinton Street plants, detector circuits only being relied on to protect against the throwing of these functions under trains. In the other three plants, where the speed of trains is on an average much higher, both detector bars and detector circuits are employed. When detector bars were not used with the No. 2 movement, a spring was applied on each movement to take its place in insuring that vibration would not operate the movement sufficiently to unlock the derails if the control circuit were broken.

The track circuits used as detector circuits were made as long as possible consistent with operating conditions, in order to cut down as much as possible the total number of track circuits required and also in a measure provide against slow-acting relays.

Continuous rail insulated joints were used. The switch rods are insulated and the switch tie plates cut so as to

leave a space of not less than two inches between the ends, as experience, covering a period of several years, demonstrated that the strength of a continuous plate between two rails is not required; also, the cut plate is much cheaper both in first cost and maintenance and can be inspected for insulation without difficulty.

The operating switchboard, the circuits of which are shown in Fig. 3, contain the main protection used for the interlocking apparatus.

The power wires from the main power switchboard pass through this board to the interlocking machine. The ammeter is inserted in the positive wire. By means of this ammeter the leverman may watch the current used to operate the switches and signals, and can tell whether they are working properly.

At Lake and Clinton Streets, several ammeters are placed on the turret of the interlocking machine.

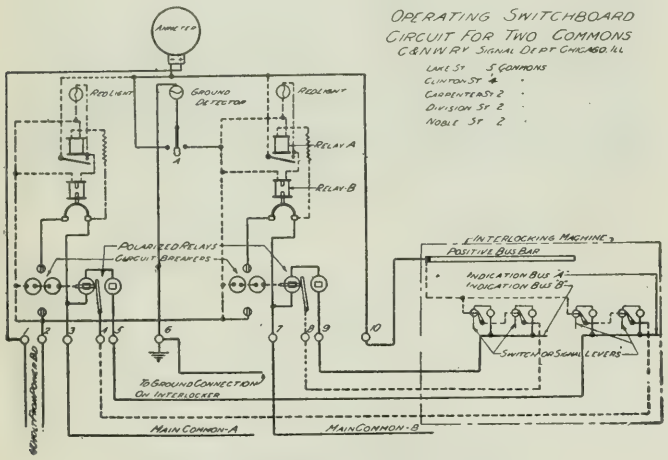


Fig. 3.—Circuits-Operating Board.

The track circuits for the interlocking plants are fed by means of loops from 20-volt storage batteries located in the towers. Two positive and two negative wires are run from the low voltage distributing board to the junction boxes in the section of the plant to be fed. The wires of the same polarity are joined at the end, thus forming loops so that current from the switchboard has two paths to any point on the loop. The loop wires can break at any place, and every point would still receive current.

On the switchboard, ammeter jacks are placed for each wire and again for the main feed wires after the loop wires have joined. A regulating rheostat is inserted in the positive lead capable of cutting the battery down to about 12 volts, at which point it is generally maintained. The track sections are fed from various points on the loop through resistance units placed on each side. These are in most cases 37.5 ohms, although on some sections the resistance has been reduced on one side to meet local conditions. These resistances are of the enclosed fuse type mounted on the terminal boards of junction boxes and manholes. During wet weather, when the leakage between rails increases, the rheostat may be used to allow more current to flow to compensate for this leakage. The purpose of the ammeter jacks is to determine when a break occurs in any of the loop wires. As long as the circuits are perfect the readings are the same, while if there is a break the readings on the No. 1 and 3 wires will be different from the readings on the No. 2 and 4 wires respectively.

In calculating the size of the wire for the loops, one side of each loop was considered cut off at the switchboard and every track circuit occupied except the one nearest the cut-off end.

The voltage required on this last track circuit must be enough to pick up its relay. The voltage on the switchboard being 12, the current used by each shunted track circuit being known, the size of wire is easily worked out. The practical limit to the number of track circuits that could be fed from a loop was found to be 20. Relays of 12 ohms are used on all circuits fed from the track circuit loops. A 12-ohm resistance unit is located in series with the relay to obtain a quick drop-away of the armature, the time being reduced 50% by the insertion of this resistance. This is very desirable on account of the detector locking.

Where the track sections are adjacent to the towers the track relays are located in the tower, but where they are too far away for efficient operation, repeater relays are placed in the tower and controlled by the track relays which are placed adjacent to the track sections.

For the train-shed track circuits two 110 volt to 20 volt direct current to direct current motor generator sets were installed in a relay room under the station platform. These feed direct to the tracks, no storage battery being used, and the sets are run successively in six hour periods.

These motor generator sets are run off the depot lighting system, and by using them instead of a rheostat, the lighting circuits and track circuits are kept separated, and any grounds which may occur on one will have no effect on the other.

At tthe signal bridges at which power-houses are located, the track circuits are each fed from a single cell of 120 ampere hour capacity storage battery with an 8-ohm resistance in series. Relays of 4 ohms are used where the track circuit is fed from these individual cells.

The release route locking circuits operate as follows:—A train entering a route locks up all switches, derails, and movable point frogs in the route, and when the train leaves each track section, all switches, derails, and movable point frogs in that section are released so that they may be moved.

This result is accomplished as follows: The circuits are divided into two general classes—the stick relay circuits and the lock circuits. The stick relay circuits are composed of the stick relay pick-up and the stick relay stick-up wires. The lock circuits are composed of the battery feed wire and the lock wire. The direction in which the locking takes effect is determined by the position of the stick relay, the relay being up when the train is going in one direction and down when going in the other. The relay is picked up by a contact on the sigal governing in the direction requiring the relay up, and is then held up by back contacts on the track relays in the route. The signal in the opposite direction does not pick the stick relay up and consequently it remains down. It will be readily seen that restoring one signal to normal position and clearing the opposing signal will reverse the route locking. This is valuable for switch-engine moves and also for those trains which are too long to completely enter the station and clear the last switch circuits of the interlocking plant.

The levers are controlled by electric locks located on top of the lever, the circuit being held normally open by a contact operated by the lever latch. A white light is in multiple with the lock and latch contact, showing at all times whether the lock can be energized or not. Each lock is controlled directly by the track relay of the section in which the switch is located, thus providing absolute detector locking, making it impossible to operate a switch lever, and therefore the switch, when the section in which that switch is located is occupied. The lock wire receives battery from a back contact of the stick relay while battery is fed to the other end of the route over the battery feed wire, when the stick relay is energized, through the front point of the relay. Thus it will be seen that when a train is going

in the direction that the stick relay is energized, battery is fed behind the train as it proceeds. When the train is proceeding in the opposite direction, the stick relay being de-energized the current is also fed from behind the train. The switches and derails by this means are always locked ahead of and under the train while those which are behind the train are unlocked. In case it becomes necessary to change a switch or derail ahead of a train which has come to a stop, current may be supplied to all locks in the route except those under the train by means of a push button so located in the tower that it requires one man to operate it while the leverman is operating the lever, thus bringing two men into operation.

On account of the number of circuits, requiring a great mass of wires, it was necessary to do the work mechanically, i.e., furnish detailed plans showing exactly how each piece of work was to be done, the workmen being required to follow these plans without any knowledge of the circuits involved.

Terminal board plans were made for every junction box and manhole, showing the wires to be spliced through, the wires to go to terminals, the location of terminals and resistance units.

In the same way, plans were made of terminal boards for junction boxes on signal bridges and for those located in the towers.

Plans of the conduits were made, showing location and size of each. Tables were furnished showing the number and size of wires in each duct, the total length of each wire, and the number of feet to be left out at each end. The number of each wire and its destination was also shown.

Plans were then furnished of the back of the relay racks, the combination board, interlocking machine proper, the release buttons, etc., showing the details for connecting the wires and using the tag numbers described above to identify them.

The circuit sheets were written instead of drawn, and by description or number gave each connection to be made and each cable or conduit through which a wire ran. This work of the drafting room saved an immense amount of work in the field.

The motor-generator set provided for charging the storage batteries is located at the signal bridges.

The batteries being in duplicate, each set of battery has a charging switch so arranged that the load is never deprived of battery. The switch is constructed so that either set of battery may be discharged with the other on open circuit or being charged. In accomplishing this result and to avoid short-circuiting the battery a resistance is inserted in the circuit in the intermediate positions. All charging switches on the switchboard are arranged in series so that any number may be cut in at the same time. The voltage of the generator is adjusted for the number of cells being charged. Terminals are provided for connecting in a portable voltmeter ammeter.

To provide for the possibility of the alternating current failing or a fuse opening in the motor end, a three-phase 220-volt relay is used, operated in parallel with the motor controlling the charging circuit. Whenever the power fails or a motor fuse opens up, this relay opens the charging circuit preventing discharge of the battery. If the power returns, after failing, the relay picks up again and restores the charging circuit. As it picks up before the motor has reached full speed, the battery current runs the generator end as a motor and aids in bringing the set up to speed without excessive overloading.

THE DESIGN OF TALL CHIMNEYS.*

(Continued from last week).

Centre of Wind Pressure.—Let h = height from bed joint to centre of gravity of diametral plane, which will be the centre of wind pressure, H = whole height of portion, D = lower diameter, and d = upper diameter, then—

$$h = H \times \frac{D + 2d}{3(D + d)}, \text{ and } p = \frac{W(\frac{1}{2}D - l)}{hH\frac{1}{2}(D+d)}$$

For rapid proof we may apply this to the square pier,

thus, $p = \frac{270(\frac{1}{2} \times 3 - 1)}{15 \times 3 \times 30} = 0.1$ cwt. $= 11.2$ lb. as before.

When Tension is Permissible.—When tension is permissible on the inner edge the wind pressure may be increased, so that the resultant is forced nearer to the overturning edge. The maximum pressure will, under these circumstances, be $K\left(\frac{W}{A} + \frac{l}{4D}\right)$ and the minimum, or tension, $k = \frac{W}{A} - \frac{6l}{D^2}$

Air and Combustion.—There are now some interesting points to note with regard to the use of the chimney. With air at 60 deg. Fahr., 30-in. bar., about 13 cu. ft., weigh 1 lb., and 12 lb. of air (156 cu. ft.) are required to combine with the constituents of 1 lb. of coal for perfect combustion, but to allow for working conditions it is necessary to provide 24 lb. (312 cu. ft.), which is equal to 700,000 cu. ft. of air per ton of coal. Putting it in another way, the air and smoke together, at a temperature of, say, 300 deg. Fahr.,

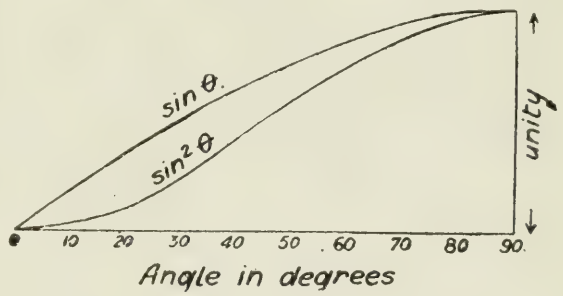


Fig. 5.

equal about 2,000 cu. ft. per cubic foot of water evaporated. The maximum economical draught for boilers is that arising from, or equivalent to, the pressure due to ½-in. head of water, causing a consumption of about 36 lb. coal per hour per square foot of fire grate area. The temperature of combustion in the furnace is about 2,400 deg. Fahr. The temperature of the gases is generally ascertained by hanging strips of metal foil in the flues on an iron wire, and noting which are melted by the heat—viz., copper 2,000 deg., aluminum 1,800 deg., zinc 750 deg., lead 630 deg., tin 440 deg. A 3-in. cast-iron pipe is sometimes built in the base of the chimney for the purpose of introducing these test pieces or a pyrometer, or for testing the suction. The temperature may be as low as 300 deg. Fahr., with any Cornish or Lancashire boilers, or as high as 1,000 deg. Fahr. with water tube boilers. At 600 deg. Fahr., which is about the usual temperature of the escaping gases, the volume of air entering the furnace is doubled on exit.

Chimney Draught.—The force of the draught in a chimney stack is the deficiency of weight of the column of rarefied air in the chimney compared with a similar column of the external air. The velocity in feet per second is, roughly, two and a half times the square root of the height in feet. As regards smoke prevention, there are several patents on the market, but a good stoker is the best smoke preventer.

Horse Power of Chimney.—The horse power of a chimney is sometimes spoken of. For a round chimney the following rules have been given:—

(1) $H.P. = 3\frac{1}{3}\ (\text{area sq. ft.} - 0.6\sqrt{\text{area}}) \times \sqrt{\text{height ft.}}$

(2) $H.P. = 2\frac{1}{2} \times \text{diam. ft.}^2 \times \sqrt{\text{height ft.}}$

(3) $H.P. = \dfrac{\text{diam. in.}^2 \times \sqrt{\text{height ft.}}}{70}$

(4) $H.P. = \dfrac{\text{diam. in.}^3}{300}$

but one would have supposed there were enough variations of horse power without introducing another.

APPENDIX.

Design for Chimney.—In order to emphasize the author's description, he now proposes to design a circular chimney for four Lancashire boilers, each having two furnaces, 2 ft. 9 in. wide × 6 ft. long, burning 12 lb. coal per square foot of firegrate per hour, and evaporating 9½ lb. water per pound of coal. The boilers themselves are 7 ft. 6 in. diameter × 30 ft. long, with Galloway tubes, and supply steam to an engine of 750 I.H.P.

Total firegrate area = $4 \times 2 \times 2.75 \times 6 = 132$ sq. ft.

Consumption of coal per hour $132 \times 12 = 1{,}584$ lb.

Consumption per week of fifty-six hours $\dfrac{1{,}584 \times 56}{2{,}240} =$ 39.6, say 40 tons.

Water evaporated per hour = $1{,}584 \times 9.5 = 15{,}048$ lb. = 1,504.8 gallons.

Water used per I.H.P. per hour $= \dfrac{15{,}048}{750} = 20.064$, say 20 lb., which fairly represents modern practice with compound condensing engines.

Area of main flue $\dfrac{132}{8} = 16.5$ sq. ft., say 3 ft. wide × 5 ft. 6 in. high, invert, say 4 ft. below ground level.

Height of Chimney:—

(a) From coal consumption, scaling from diagram, 40 tons per week = 140 ft. high.

(b) From length of flues, chimney being 28 ft. from further boiler. Three times length of boiler + twice length of main flue = $3 \times 30 + 2 \times 28 = 146$, but there is something inviting about round numbers, so that 140 ft. may be decided upon as the height above ground level, or 150 ft. in all.

Sectional Area of Chimney:—

(a) From coal consumption $= \dfrac{1{,}584}{112} = 14.14$ sq. ft.

(b) From firegrate area $= \dfrac{132}{10} = 13.2$ sq. ft.

(c) From indicated horse power (I.H.P.) of engine $= \dfrac{750 \times 2\frac{1}{2}}{144} = 13.02$ sq. ft.

(d) From coal consumption and height $= \dfrac{1{,}584}{12\sqrt{150}} = 10.8$ sq. ft.

(e) From firegrate area and height $= \dfrac{132}{1.5\sqrt{150}} = 7.18$ sq. ft.

An allowance of 14 sq. ft. should therefore be ample without any further allowance for friction. Reference to a table of areas shows that 4 ft. 3 in. diameter = 14.18 sq. ft. area, which may be decided upon as suitable.

Height of firebrick lining, $\dfrac{150}{5} + 10 = 40$ ft.

SKETCH SECTION.

Data.—Main flue 5 ft. 6 in. by 3 ft., invert 4 ft. below ground level. Chimney 140 ft. high, 4 ft. 3 in. least internal diameter. Lining 40 ft. high, 20 ft. of 9-in. thick and 20 ft. of 4½-in. vertical. Batter not less than 2½ in. in 10 ft.

Least permissible outside diameter at ground line $\dfrac{140}{12} = 11$ ft. 8 in. Thickness of shaft, say, 20 ft. of 1 brick, 20 ft. of 1½ brick, 20 ft. 2 brick, 20 ft. of 2½ brick, 20 ft. of 3 brick, 20 ft. of 3½ brick, 20 ft. of 4 brick, remainder of 4½ brick. Projection of cap 9 in.

The diameter at ground line requires to be 2/3′ 4½″ + 2/1½″ + 2/9″ 4′ 3″ = 12′ 9″. The diameter at top requires to be 2/9″ + 4′ 3″ = 5′ 9″, which fortunately gives the round number of 7 ft. for taper, or 3′ 6″ batter on each side = 42 in. in 140 ft. $= \dfrac{42}{14}$ ins. in 10 ft. = 3 in. in 10 ft., or each 20-ft length increases 1 ft. in diameter.

If the upper half of the firebrick lining stands central on the lower half, the clearance at top of former will be found thus: $\dfrac{36}{10} \times 3 = 10.8$ in. batter, $10.8 \times 2 = 21.6$, say 1′ 9½″ taper, reduced outside diameter 12′ 9″—1′ 9½″ = 10′ 11½″. Inside diameter of shell = 10′ 11½″—2/2′ 7½″ = 5′ 8½″. Outside diameter lining = 4′ 7½″ + 2/4½″ = 5′ 4½″. Clearance = ½ (5′ 8½″—5′ 4½″ = 2 in. at top of firebrick lining to be covered by oversailing course projecting, say, 4 in., and with clearance above top of not less than $\dfrac{40}{5} \times \frac{1}{8}$ = 1 in. to allow for expansion.

The clearance outside lower length of firebrick lining at junction with upper length will be $\dfrac{16}{10} \times 3 = 4.8$ in. batter, $4.8 \times 2 = 9.6$ in., say 9½-in. taper, reduced outside diameter 12′ 9″—9½″ = 11′ 11½″, inside diameter of shell = 11′ 11½″—2/3′ 0″ = 5′ 11½″. Outside diameter of lining = 4′ 3″ + 2/9″ = 5′ 9″. Clearance = ½ (5′ 11½″—5′ 9″) = 1¼ in., which will be satisfactory, but before the design is proceeded with further the stability should be calculated.

Calculation of Stability.—The first step in calculating the stability is to determine the weight of each portion between the various set-offs. Suppose the material to be picked stock bricks laid in lias mortar, the weight may be taken at 112 lb. per cubic foot.

Weight of Each Length.—

$$\text{Top length} = \pi h t \left(\frac{D + d + \sqrt{Dd}}{3} - t \right) \times 112 = 3.1416 \times 20 \times 0.75 \left(\frac{5.75 + 5.75 + \sqrt{6.75 \times 5.75}}{3} - 0.75 \right) \times 112 = 47.124 \times 5.493 \times 112 = 28991.5 \text{ lb.}$$

2nd length	=	48371.68 lb.
3rd "	=	71147.44 lb.
4th "	=	97148.08 lb.
5th "	=	126509.60 lb.
6th "	=	159230.40 lb.
7th "	=	195096.16 lb.

Weight Above Each Set-Off.—The weights will be required in totals above each set-off; they may therefore be collected as follows:—

1st set-off	.....	=	28991.50
2nd "	28991.50	+	48371.68	= 77363.18
3rd "	77363.18	+	71147.44	= 148510.62
4th "	148510.62	+	97148.08	= 245658.70
5th "	245658.70	+	126509.60	= 372168.30
6th "	372168.30	+	159230.40	= 531398.70
7th "	531398.70	+	195096.16	= 726494.86

Areas of Bed Joints.—The next step is to find the sectional area at the lower end of each portion—i.e., the bearing surface at each set-off—viz., $A = \frac{\pi}{4}(D^2 - d^2)$, d being now inside diameter.

1st set-off	.7854	$(6.75^2 - 5.25^2)$	= 12.74
2nd "	.7854	$(7.75^2 - 5.50^2)$	= 12.74
3rd "	.7854	$(8.75^2 - 5.75^2)$	= 34.16
4th "	.7854	$(9.75^2 - 6.00^2)$	= 46.34
5th "	.7854	$(10.75^2 - 6.25^2)$	= 60.08
6th "	.7854	$(11.75^2 - 6.50^2)$	= 75.20
7th "	.7854	$(12.75^2 - 6.75^2)$	= 91.84

Mean Pressure.—The mean pressure due to the direct load will also be required at each set-off—viz., $m = \frac{W}{A}$,

1st set-off $\frac{289991.5}{12.74 \times 2,240}$ = 1.01 tons per sq. ft.

2nd "	.....	= 1.45	"	"
3rd "	.....	= 1.91	"	"
4th "	.....	= 2.34	"	"
5th "	.....	= 2.79	"	"
6th "	.....	= 3.16	"	"
7th "	.....	= 3.53	"	"

Moduli of Section.—The modulus of section corresponding to each of these sectional areas—viz., $Z = \frac{\pi}{32}\left(\frac{D^4 - d^4}{D}\right)$ d being inside diameter, will be—

1st set-off $0.101 \left(\frac{6.75^4 - 5.25^4}{6.75}\right)$ = 19.65

2nd "	.....	= 35.10
3rd "	.....	= 55.20
4th "	.....	= 80.42
5th "	.....	= 111.43
6th "	.....	= 148.91
7th "	.....	= 185.28

Height of Centre of Wind Pressure.—The height of centre of wind pressure—i.e., centre of gravity of diametral plane—above each set-off—viz., $h = H \times \frac{D + 2d}{3(D + d)}$, d being top diameter, will be—

Above 1st set-off $20 \times \frac{6.75 + 2 \times 5.75}{3(6.75 + 5.75} = 9.73$

" 2nd "	$40 \times \frac{7.75 + 2 \times 5.75}{3(7.75 + 5.74}$	= 19.00
" 3rd "	.....	= 28.00
" 4th "	.....	= 36.50
" 5th "	.....	= 45.40
" 6th "	.....	= 53.64
" 7th "	.....	= 61.74

Width at Centre of Pressure Above Each Set-Off.—This will be given by the formula $w = D - \frac{h}{H}(D - d)$, where h height of c.g. of diametral plane above set-off, H = whole height above ditto, D = diameter at set-off, d = diameter at top.

1st set-off $6.75 - \frac{9.73}{20}(6.75 - 5.75) = 6.75 - \frac{9}{20} \times .487 = 6.26$

2nd "	.....	= 6.80
3rd "	.....	= 7.36
4th "	.....	= 7.92
5th "	.....	= 8.48
6th "	.....	= 9.07
7th "	.....	= 9.67

Wind Pressures.—The wind pressure on each portion, according to the formula from which the table is constructed, will be $\log p = 1.125 + 0.32 \log (h+g) - 0.12 \log w$, where g is height of set-off in question above ground line, and h centre of pressure as in last paragraph.

Above 1st set-off, $\log p = 1.125 + 0.32 \log (129.73) - 0.12 \log (6.26)$
$= 1.125 + 0.32 (2.1130404) - 0.12 (.796574)$
$= 1.125 + .6761729 - .095588$
$= 1.7055840$
$\therefore p = 50.76$

Above 2nd set-off	"	= 48.89
" 3rd "	"	= 47.10
" 4th "	"	= 45.22
" 5th "	"	= 42.83
" 6th "	"	= 40.50
" 7th "	"	= 38.00

Area of Diametrical Planes.—The areas of the diametrical planes above each set-off will be $d = \frac{1}{2}(D+d)H$, where D = diameter at set-off, d = top diameter, H = whole height above set-off.

1st set-off	$= \frac{1}{2}(6.75 + 5.75)20$	= 125	sq. ft.
2nd "	$= \frac{1}{2}(7.75 + 5.75)40$	= 270	"
3rd "	$= \frac{1}{2}(8.75 + 5.75)60$	= 435	"
4th "	$= \frac{1}{2}(9.75 + 5.75)80$	= 620	"
5th "	$= \frac{1}{2}(10.75 + 5.75)100$	= 825	"
6th "	$= \frac{1}{2}(11.75 + 5.75)120$	= 1,050	"
7th "	$= \frac{1}{2}(12.75 + 5.75)140$	= 1,295	"

Bending Moment Due to Wind Pressure.—The bending moment due to wind pressure above each set-off, taking coefficient for circular chimney as

$\frac{\pi}{4}$, will be $\frac{\pi}{4} p a h$.

1st set-off $\frac{.7854}{} \times 50.76 \times 125 \times 9.73$
$= 18.52$ ft.-tons.

2nd " $\frac{.7854}{} \times 48.89 \times 270 \times 19.00$
$= 75.24$ ft.-tons.

3rd "	= 172.10	ft.-tons.
4th "	= 307.48	"
5th "	= 481.25	"
6th "	= 683.80	"
7th "	= 911.46	"

Stress Due to Bending Moment.—The stress due to bending moment only will be $\frac{M}{Z}$, thus:—

1st set-off $\frac{18\cdot52}{19\cdot65} = 0\cdot94$ tons per square foot.

2nd " $\frac{75\cdot24}{35\cdot10} = 2:14$ " "

3rd " $\frac{172\cdot10}{55\cdot20} = 3\cdot11$ " "

4th " $\frac{307\cdot48}{80\cdot42} = 3\cdot82$ " "

5th " $\frac{481\cdot25}{111\cdot43} = 4\cdot31$ " "

6th " $\frac{683\cdot80}{148\cdot91} = 4\cdot60$ " "

7th " $\frac{911\cdot46}{185\cdot28} = 4\cdot91$ " "

Maximum Pressures.—The maximum compression on the leeward edge of chimney at each set-off under the full theoretical wind pressure may now be obtained by the formula $K = m + \frac{M}{Z}$ and the tension on the inner edge $k = m - \frac{M}{Z}$

			Tons per sq. ft.
1st set-off	1.01 + 0.94 = 1.95	comp.,	0.07 comp.
2nd "	1.45 + 2.14 = 3.59	"	0.79 tens.
3rd "	1.91 + 3.11 = 5.02	"	1.20 "
4th "	2.34 + 3.82 = 6.16	"	1.48 "
5th "	2.79 + 4.31 = 7.10	"	1.52 "
6th "	3.16 + 4.60 = 7.76	"	1.44 "
7th "	3.53 + 4.91 = 8.44	"	1.38 "

The safe load on the material according to the limits laid down being 8 tons per square foot, the result shows a trifle over, but not sufficient to necessitate any alteration in the design.

Cap and Base.—No account has been taken of the weight of cap nor of the extra surface it exposes to the wind, but the effect of these will be so slight that the stability will not be affected thereby. The part immediately above ground will usually be in the form of a square pedestal externally, with cornice, plinth and base; this will add considerable sectional area at the lowest set-off, reducing the maximum pressure, but increasing the whole load on foundations.

No Tension on Inner Edge.—If tension is not to be permitted on the inner edge then we must find the maximum wind pressure permissible by the formula $l = \frac{3D^2 - d^2}{8d}$ (d being inside diameter) and $p = \frac{W(\frac{1}{2}D - d)}{hH\frac{1}{2}(D+d)}$ (d being top diameter).

Then $l = \frac{3 \times 12\cdot75^2 - 6\cdot75}{8 \times 12\cdot75} = 4\cdot33456$ and

$p = \frac{726494\cdot8604 \times 12\cdot75 - 4\cdot33456)}{61\cdot74 \times 140(12\cdot75 + 5\cdot75)} = 18\cdot54$ lb. per square foot as the mean effective pressure over the whole area, but being cylindrical, the equivalent normal pressure on a plane surface would be $\frac{18\cdot54}{0\cdot7854} = 23.6$ lb. per square foot, or, according to Rankine's coefficient, $\frac{18.54}{0.5} = 37$ lb. per sq. ft.

Summary.—It will thus be seen that, unless extraordinary means are taken to secure stability beyond the allowances that have been made in the design, a wind pressure varying from 38 lb. to 50.76 lb. per square foot will cause a maximum compression of 8.44 tons per square foot and a maximum tension of 1.52 tons per square foot, both being within the safe limits of the material, but that if no tension is to be allowed on the inner edge the wind pressure must not exceed an average of 23.6 lb. per square foot, or 37 lb.

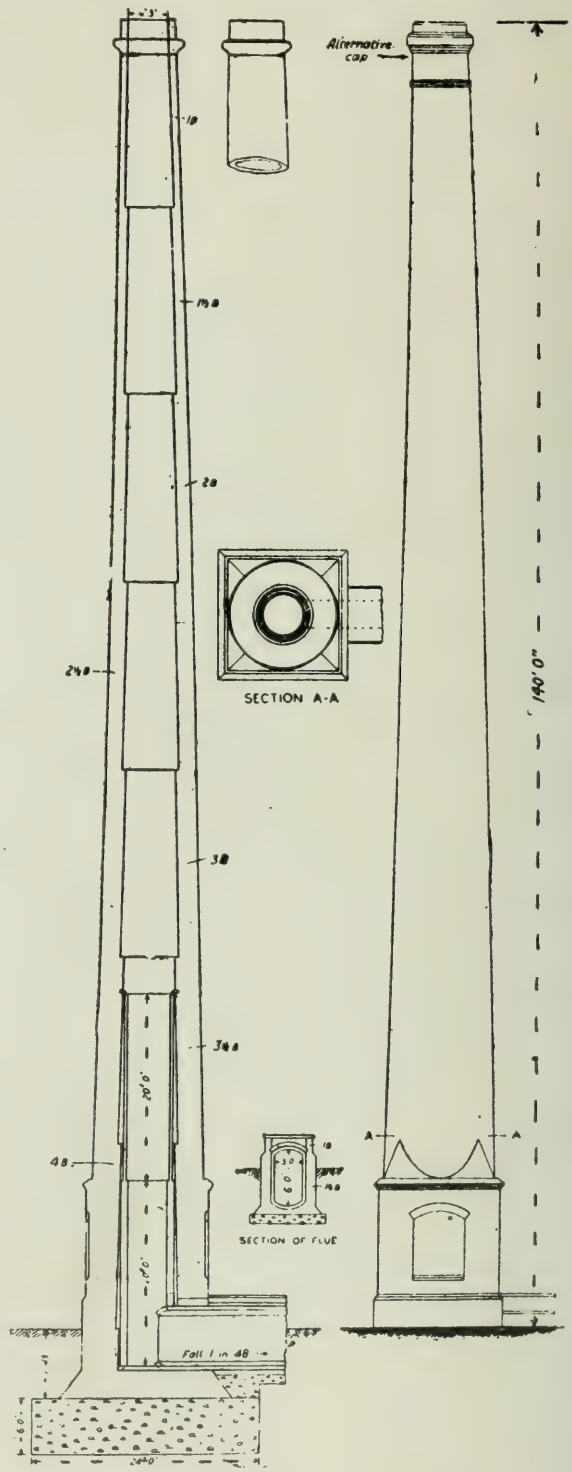


Fig. 10.
Design Accompanying Prof. Henry Adams' Paper on "Tall Chimneys."

(according to the coefficient taken), against a normal plane surface.

Prof. Unwin says (in "Bridges and Roofs," p 119): "We are in this country visited annually by gales, singularly constant in their maximum force, amounting to from 20 lb. to 25 lb. per square foot, on a surface perpendicular to their direction. More rarely cyclonic storms sweep over the country, during which still higher pressures are registered. A pressure of 30 lb. was registered during the Royal Charter storm; one of 33½ lb. was observed at Greenwich in the storm preceding the fall of the station roof at Manchester. Higher pressures still, up to as much as 55 lb., have been recorded at various times, but the accuracy of these observations is more doubtful. We shall probably allow margin enough for the worst contingency if the maximum pressure of the wind is assumed at 40 lb. per. square foot of a surface perpendicular to its direction.

Concrete Base.—The size of the concrete base will depend to some extent upon the nature of the soil, but it must be wide enough to avoid any risk of tilting under maximum wind pressure. This may be calculated as follows, assuming the concrete base to be 24 ft. square and 6 ft. deep—

Weight of shaft	.....	726,495. lb.
" plinth, say	....	83,628 "
" footings, say.		163,632 "
" concrete, say.		414,720 "
		1,388,475 " = say, 620 tons.

Then $m + \frac{M}{Z} = \frac{620}{24 \times 24} + \frac{911.46}{\frac{1}{6} \times 24^3} = 1.472$ tons per square foot maximum compression, and 0.681 tons per square foot minimum compression on the earth below the concrete.

Protection from Lightning.—The lightning conductor should consist of a coronal or copper band round the top of chimney, with copper needles, 6 in. long, fixed at intervals of 3 ft. or 4 ft., the points being platinized, gilded, or nickled, to prevent corrosion. The main conductor should be not less than 1 in. × ¼ in., securely attached to the coronal by a clean metal-to-metal connection, and be carried down side of shaft without insulation, but held by projecting holdfasts and clips every 4 ft. to 6 ft. The lower end should be carried down 2 ft. under the ground and 10 ft. away from the base, riveted and soldered to a sheet of copper 4½ sq. ft., area, 1/16 to ⅛ in. thick, and embedded in moist earth or coke-breeze. A tube well, as adopted by Mr. Killingworth Hedges, forms the best earth terminal when there is any doubt about the moisture round the copper being permanent.

Completion of Design.—The design may now be completed as shown.

Cost of Chimney.—The cost of building a tall brick chimney shaft is approximately 1s. 3d. to 1s. 6d. per cubic foot of the solid materials, labor alone being 4d. to 6d. per cubic foot, but much, of course, depends upon locality, quality of materials, and cost of labor.

Classification of Wind Force.—The classification by different writers of the force of the wind varies considerably. The following is a fair average:—

Description.	Velocity in miles per hour.	Approximate corresponding pressure lb. per sq. ft.
Barely perceptible wind ..	2½	1/32
Light breeze	5	⅛
Pleasant breeze	7½	¼
Good breeze	10	½
Strong breeze	15	1⅛
High wind	20	2
Half gale	30	4½
Strong gale	40	8
Whole gale	50	12½
Great storm	60	18
Hurricane	80	32
Violent hurricane	100	50

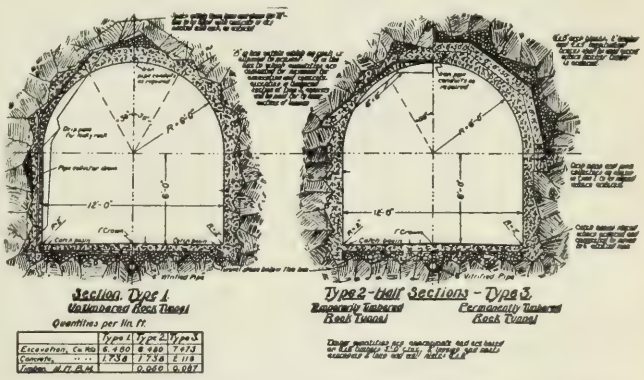
By Smeaton's formula $p = \frac{V^2 \text{ miles per hour}}{200}$

Alphons Custodis Chimneys.—The Alphons Custodis Chimney Construction Company have built a large number of tall chimneys in America and England, their specialty being radial perforated bricks, which appear to have every advantage but that of weight. Weight being one of the elements of stability, its reduction can only be compensated for by increase of one or more of the other elements, such as batter of shaft, diameter at base, or the tensile and compressive strength of bricks and jointing material. This company claim that the strength of their brickwork enables them to design very economical and efficient chimneys, but one would like to learn a little more about the wind pressure they are capable of resisting.

Improving an Old Chimney.—A chimney not powerful enough for its work may be improved by lengthening, or by the application of a moderate forced draught, such as the Meldrum system of steam jets in a closed ashpit. This system can also be made powerful enough to do the whole work with only a short iron shaft, but iron or steel shafts are very perishable, and brickwork is worth the extra cost, particularly as a tall chimney discharges the foul gases of combustion at a better height for dilution by the atmosphere. The importance of the latter point will be understood from the fact that the boilers described above would discharge about 40,000 cu. ft. of carbonic acid gas per hour into the atmosphere.

UNDERGROUND STREET CONSTRUCTION.

A proposed underground highway for foot traffic, to be built in the upper section of New York, will affect a populated area of half a square mile or more, and will bring about a saving of a quarter to a third of a mile walk to a large number of citizens who are required to use the subway frequently. This tunnel is to overcome the circuitous routes to Dyckman or 181st streets.



Typical Cross Sections—Tunnel Street, New York City.

The tunnel will open off from Broadway at grade a few feet from Fairview Avenue. The general level of the floor will be reached by going down two short flights of steps. The "street" will run 904.40 feet straight away down a 1.09 per cent. grade to a point 35.18 feet west of the subway station and then turn practically at right angles ending in front of the elevator by which the Interboro Company con-

veys its passengers to and from the street, 153 feet above.

The tunnel will be twelve feet wide and twelve feet high in the clear, the sides running up six feet straight to the arched roof, which will have a radius of six feet.

The entire construction will be of concrete reinforced with steel in the walls and roof, and permanently shored with timbers where necessary. With the exception of 173 feet at the street end of the tunnel, the entire excavation will be through solid rock, which fact of course greatly increases the cost of construction.

The contract for the construction of Tunnel Street has been awarded to Roswell D. Williams, 21 Park Row, Manhattan, at an aggregate bid of $72,260. An itemized schedule of the prices follows: 5,900 cu. yds. of rock excavation at $6.75 per yd., 2,300 cu. yds. of earth excavation at $1.20 per yd., 1,200 cu. yds. of refilling at 30 cts. per yd., 2,200 cu. yds. of concrete at $7.78 per yd., 750 cu. yds. of excess concrete at $6 per yd., 200 cu. yds. of dry packing at $2 per yd., 30,000 ft. (B.M.) of timber at $30 per M., 1,000 lin. ft. of galvanized wrought iron pipes at 50 cts. per ft., 800 lin. ft. of 6-in. pipe drain at $1 per ft., 360 sq. ft. of concrete (steps, landing, sidewalk, etc.) at 40 cts. per ft., 10 catch basins at $20 each, 33 sq. yds. of surfacing at 15 cts. per yd., 11,000 lbs. of steel beams and girders at 5 cts. per lb., 5,000 lbs. of steel rods and bars at 4 cts. per lb., 11,000 sq. ft. of floor finish at 10 cts. per ft., electric system (for lighting) complete $1,150.

The construction of the tunnel is expected to have an appreciable influence on the development of that section of Manhattan which it affects.

The difficult and devious approaches to the subway stations have hitherto constituted an indubitable and serious deterrent to the popularity as a residental section of a large area in that neighborhood. With its electric lights, adequate drainage and ventilating provision and equable temperature, the underground street will do much to relieve the discomfort of the transit situation.

PRESERVATION OF POWER TRANSMISSION POLES.*

By W. R. Wheaton.

The increasing cost of power transmission poles in recent years and the high maintenance charges have turned the attention of power companies to some process to increase the life of the poles and to cut down the maintenance charges. The first cost of the poles has nearly doubled in the past six years, and these two factors have been largely responsible for the interest shown by operating power companies in pole preservation.

In March, 1908, the San Joaquin Light & Power Corporation set a line of Western yellow pine (Pinus ponderosa) poles. The line is about 30 miles long and contains approximatel 6000 poles. These poles were cut in the Sierras above Fresno at an elevation of about 4,000 ft., and were thoroughly seasoned before treatment. Some of the poles received a brush treatment with carbolineum and with creosote, and the rest were treated in an open tank with creosote, zinc chloride and crude oil. The butt only was treated. Western yellow pine is very susceptible to a preservative treatment. Some of the butts were thoroughly penetrated with creosote and with zinc chloride, the average penetration (at the ground line) being 3 in. The penetration with crude oil averaged about 1½ in. The crude oil used was a heavy oil of asphaltum base supplied from the Kern River fields. In order to get a comparative life of the wood treated and untreated, stubs of untreated timber were set along the line about a mile apart. The writer inspected this line in June, 1910, at which time it had been set for twenty-seven months. The untreated stubs set along the line were completely rotten. Of the poles brush-treated with carbolineum and creosote the conditions were about the same, a large percentage of each showing signs of decay; 27 per cent. of the poles that had a brush treatment with creosote showed signs of decay, and 29 per cent. of the poles that has treatment with carbolineum showed decay, while 45 per cent. of the poles treated with crude oil were slightly attacked by decay. Of the poles treated with zinc chloride, 28 per cent. showed attack by decay. The poles treated with creosote in the open tank (over 50 per cent. of the entire line were treated in this way) were all perfectly sound and showed absolutely no signs of decay.

In August, 1911, two of the poles in this line which had received a brush coating of creosote fell over, owing to decay at the butt. During August and September, 1911, the line was gone over and all of the poles which had had a brush treatment of creosote or carbolineum were so badly decayed that they were strapped to a creosoted cedar stub.

The above results speak for themselves. The value of the experiment is apparent and is enhanced by the fact that the timber used will entirely decay, without treatment, in a year.

The San Joaquin Light & Power Corporation is now treating Western red cedar poles at the butts only by the open-tank process. There is no necessity for treating the top, since the top is not subject to decay. With this process the outer ring of sap wood on the cedar poles is filled with creosote, and if the timber is thoroughly seasoned before treatment there is little difficulty in accomplishing this. The penetration varies from ½ in. to 1 in. with an absorption of from 7 lb. to 9 lb. per cubic foot. As for the efficiency of the treatment, treated and untreated cedar poles have been set for four years. The creosoted poles are still perfectly sound, while the poles set untreated have decayed through the sap wood and into the heart.

The question has been asked why zinc chloride, copper sulphate or some preservative other than creosote has not been used to cut down the treatment charges. It was found that several poles treated with chloride of zinc were, after the installation of irrigation systems, in the middle of irrigated fields. The zinc was washed out of them, and the poles had to be replaced after a service of two years. The saving in the cost of treatment by the use of a metallic salt would not mean a saving in the end if many such replacements took place. A 50-ft. creosoted pole placed in the line means an investment of about $25. The use of chloride of zinc would cut this cost to about $24.25, and the saving is too small to be considered against the possibility of the loss of the preservative by leeching out after one or two years.

* Abstract of a paper read at the annual meeting of the Wood Preservers' Association, Chicago. Ill., Jan. 16-18, 1912.

SALT IN ONTARIO.

The occurrence of salt in that part of Ontario which lies entirely in the southwestern peninsula bordering Lake Huron, the St. Clair River, Lake St. Clair, and the Detroit River, according to such exploratory boring as has been done, indicates that there are a number of separate relatively small basins. The beds range from mere seams to formations 200 feet or more in thickness. The supply of salt in Ontario is practically inexhaustible. The bulk of the salt manufactured is used in Ontario. The quantity of salt produced in 1910 was 84,071 tons, valued at $414,978, as compared with 77,490 tons, valued at $389,573, in 1909.

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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THE C. N. R. IN MONTREAL.

Some very interesting problems are suggested in the undertakings of the C.N.R., which will be commenced in Montreal next spring. The construction of the three-mile tunnel under Mount Royal will, of course, occupy first place among these. It would now appear that shafts from the surface of the ground may be sunk down to the tunnel at different points throughout its length, and that elevators may there be installed for the purpose of making connections for passengers. One of these shafts will probably be located half a mile or so from the north portal of the tunnel to accommodate residents in that vicinity. It is just possible that a shaft may also be sunk near the site of the look-out, so that sightseers may have access to the mountain through the C.N.R. tunnel and elevator.

At the south portal of the tunnel the line will emerge into daylight at the same level as the present Windsor Depot of the C.P.R., and will then reach across to the harbor. The tracks will be elevated all the way. Near the harbor a freight yard will be provided, the yard being elevated. It is figured that this will possess many advantages over the customary freight yard.

It is suggested that the tunnel should be connected with the subway system, which, it is believed, the requirements for rapid transit will necessitate before long, in such a manner that passengers will be enabled to transfer from one system to the other without coming to the surface.

GOOD ROADS.

On Thursday last a deputation, representative of all parts of Canada, waited upon the members of the Dominion Government to bring up the subject of "Good Roads." The delegation, which numbered about four hundred, urged that there should be aid given by the Federal Government for good roads construction. The inception of the Good Roads policy, the Act for which is now before the House, has been long demanded, and it is certain that this representative gathering will have great effect in securing prompt action. While the question of Good Roads is primarily one for the local municipalities, the counties and the provinces to handle, there is no doubt the Dominion Government can do a great deal to aid the movement. In all probability this aid will be in the form of grants to the Provincial Government for the construction of roads. It is outside their jurisdiction, however, to provide for maintenance.

Aside from the question of grants of money for purposes of constructing roads, the Federal Government must take up the question of the establishment of a Bureau of Highways. If there is to be an extensive system developed throughout the country, there must be developed and trained experienced road superintendents to take charge of the work. Definite standards and uniform methods must be laid down if there are to be adequate results for the expenditure in this connection. Therefore, it would seem that the most urgent matter for the Dominion Government to take up, ranking in importance above the question of grants for construction, is the establishment of a Department of Roads along the lines of the Office of Public Roads of the United States. This Department, however, in our opinion, should not form or be associated with the Department of Agriculture. In the United States such is the case, and at the Convention of Road Builders, recently held in Rochester, the suggestion was made that instruction for highway engineers should be given in the agricultural colleges. This is a mistake, as

the logical place for the giving of such instruction is in the Engineering Faculties of our universities. These faculties have the necessary testing laboratories, and by the addition to their teaching staff of trained highway engineers, adequate instruction in the science of road-making can be given. The problems of road construction properly come under the engineer's work, and, therefore, can be better solved by him.

With a strong Department of Roads valuable data with reference to the wear of different types of roads, the compiling of specifications, etc., can be collected and made available for use throughout the Dominion. There is little question that such a Department is urgently required at the present time.

ENGINEERING STANDARDS COMMITTEE.

The question of an Engineering Standards Committee for Canada has been brought up and discussed a number of times, and it is a matter which must be finally settled at an early date if the engineering profession and the manufacturers are to secure the advantages of standardization of the different materials of construction. The seventh report on the work accomplished by the Engineering Standards Committee of Great Britain has recently been published; this is a document which records the progress in connection with standardization. The personnel of the committee and some idea of their work was published in the January 18th issue of *The Canadian Engineer*. It is interesting to note the progress made during the past year. The report states that the recommendations of the committee for sizes and for tests of materials continue to find their way gradually but surely into a very general use. The use of British Standard tramway rails is continued, the British Standard sections rolled during the year ending March, 1911, amounting to nearly 70 per cent. of the total tonnage produced.

The report states that a proposal has been submitted to the committee for the re-designing of the Standard Sections of tramway rails, so that they may have a uniform width of head throughout the series. The reason for this suggestion is that in the country lighter rails than those employed in the towns could then be laid, while still preserving the same width of head. At present the widths of the tires of cars intended for travelling over the heavier and broader sections are rather wide for the lighter and narrower sections. This subject is receiving the careful attention of the sub-committee concerned, but, having regard to the very extensive use of the existing standard sections, no alteration should be made unless it is clearly advantageous, and is backed by some evidence of a general desire for a change. Among other matters which have been dealt with by the committee, and in respect of which specifications or drawings will be issued shortly, are cast-iron pipes for house drainage, water, gas, and sewerage purposes.

Progress is being made with the standardization of vitrified ware pipes, and in this matter full acknowledgment is made of the assistance which is being afforded by the Institution of Municipal and County Engineers. That body has tabulated the data obtained from its members, and a report has been presented to the committee. A meeting was held to discuss the lines upon which standardization should proceed, and the manufacturing members have beeen aked to consult together and carry out tests with a view of formulating proposals which will be considered in conjunction with those received on the engineering side from the Institution of Municipal and County Engineers.

NEW PSYCHROMETRIC FORMULAE FOR USE IN AIR CONDITIONING.

A specialized engineering field has recently developed, technically known as air conditioning, or the artificial regulation of atmospheric moisture, the application of which to many varied industries has been shown to be of great economic importance.

The following information is abstracted from a paper by Willis H. Carrier, in the November Journal of the American Society of Mechanical Engineers:—

In the blast-furnace work it has increased the net profit in the production of pig iron from 50 to 70 cents per ton, and in textile mills it has increased the output from 5 to 15 per cent., at the same time greatly improving its quality and the hygienic conditions surrounding the operatives. The question of humidity is equally important in many other industries, such as lithographing, the manufacture of confectionery, bread, high explosives and photographic films, and the drying and preparing of delicate hygroscopic materials, such as macaroni and tobacco.

It is believed that its proper application in coal mines would prevent explosions to a great extent.

Accepted data used in psychrometric calculations are based largely on empirical formulae which are incorrect and also limited in their range. The author has therefore developed the following rational expressions, based on the established principles and laws governing atmospheric moisture, the latest results obtained by investigators of the properties of steam and water vapor, and data obtained from his own experiments.

Grains of moisture per pound of pure air at saturation =

$$G = 5284Ds\ (t + 459.64) \div (P - e) \quad \ldots\ldots(1)$$

in which

t = Temperature of saturation, deg. F. ($t + 459.64$ = absolute temperature).

Ds = Density of saturated water vapor at temperature t, lb. per cu. ft. = reciprocal of specific volume of steam (as per values in Marks & Davis steam tables).

$P = 29.92$ = assumed standard of barometric pressure, in. of mercury.

e = vapor pressure of saturated water vapor, in. of mercury.

Also,

$$e = e^1 - [(P - e^1)\ (t - t^1)] \div (2800 - 1.3t^1) \quad \ldots\ldots(2)$$

in which

e = vapor pressure at dry-bulb temperature t.

e^1 = vapor pressure at wet-bulb temperature t^1.

This equation should be used where the true wet-bulb temperature is ascertained by using an aspiration psychrometer. When a sling psychrometer is used, an average correction of 1.6 per cent. must be made for radiation error, making formula read:

$$e = e^1 - [(P - e^1)\ (t - t^1)] \div (2755 - 1.28t^1) \quad \ldots\ldots(3)$$

Formulae (2) and (3) will give values of e with an error of less than 0.5 per cent., assuming Swann's value of the mean specific test of the air between t and t^1 to be correct.

Per cent. of relative humidity = $R = e \div e_2$, in which e is taken from (2) and e_2 = vapor pressure corresponding to saturation at the dry-bulb temperature t.

Let W = grains of moisture per cu. ft. at any vapor pressure e, and W_2 = grains per cu. ft. at e_2; then $W = RW_2$; also, $W = W_1\ (460 + t^1) \div (460 + t)$, in which W_1 = grains per cu. ft. corresponding to the dew point at vapor pressure e.

POWER PRODUCTION IN ISOLATED PLANTS AND COSTS.

In a paper presented to the American Institute of Electrical Engineers, Mr. P. R. Moses gives some interesting figures on the cost of making electricity. The following is abstracted from his paper:—

If heating is a negligible matter, as it is in tropical countries and in many manufacturing and industrial establishments, the choice of a prime mover is governed by the balance between investment and efficiency.

The high efficiency modern producer gas engine and the oil engine by their simplicity and reliability offer many advantages over the high pressure steam plant, and where steam is not used for other purposes to an extent proportional to the power requirements, the tendency is rightly, I think, toward this type of plant.

Two producer gas engine plants recently installed have given results fully equal to the guarantees, and a kilowatt-hour can be and is regularly produced at the switchboard under regular operating conditions for about two pounds of No. 1 buckwheat anthracite or pea coal, and this in plants of a few hundred kilowatts capacity.

One of these plants, of 175 kw. capacity, of which the load curve is given, is making current for 1.14 cents per kilowatt hour, including fixed charge on a power house, etc., for a duplicate equipment. These are the owners' figures and include all charges.

The other plant, a 600-kw. plant, divided into three units is using 1.75 pounds of pea coal per kw.-hr. under regular working conditions, including all fuel used for banking.

As the cost of the gas producer plant is no higher than that of a high efficiency steam plant, the relative merits under the conditions outlined hardly need elaboration.

On the other hand, in another plant, belonging to the same company for which the gas engine plant was installed, the steam engine offered the correct solution for at least part of the plant, because the electricity was practically a by-product of the concentration and evaporation of the sugar solution.

In many instances a combined steam engine and producer gas or oil engine plant offers the best solution, the steam plant being installed to such extent that its exhaust may be fully utilized.

With such equipment, with the exhaust gases from the gas engine used to heat reed water from the boilers, an almost ideal operating condition exists for at least part of the year.

I have investigated a number of isolated plants, operated by oil engines, and find particularly in the small plants that they are giving remarkable service. Almost universal testimony is to the absence of trouble and the reliability of the small sets. With the large units the heavy parts and the unfamiliarity of the operators have given some trouble, but in general the results are satisfactory.

The necessity for steam boilers and the space conditions in city buildings usually preclude any type of plant but steam unless the building is planned from the inception for the gas engine or oil egine equipment. As the engineer is frequently not called in until the general plan is adopted and as space beyond a certain amount is often extremely precious, the usual isolated plant in city buildings in the East is a steam plant.

Costs of Making Electricity.—Some kilowatt-hour costs in buildings follow: These costs are derived by deducting from the total operating cost of the building with an electric plant, the cost of operating without an electric plant. This latter cost is either actual or estimated, depending upon whether street service had been used prior to the installation of the private plant or not. In each instance the fact is stated. I do not go into particulars of each plant because there have been many such figures printed. They are, however, as closely correct as I can make them and are taken from the regularly monthly plant reports.

Where the costs are given for different seasons, the variation is due, of course, to the high cost of supplying heat and engineers services, etc., during the winter and the relatively low cost of these services during the summer.

The kilowatt-hour costs do not include fixed charges unless otherwise stated.

My reason for excluding fixed charges is that each case presents a different condition. Money may be worth 25 per cent. to one man and 3 per cent. to another. With the cost of making electricity before him, each man can then decide if this cost is sufficiently less than the central station charge to warrant investment.

Kilowatt-Hour Costs.

Loft building.—100 by 100 ft. (30 by 30 m.) 12 stories and basement.

Month.	Kw.-hr.	Total cost.	Basic cost.	Mfg. cost.	Mfg. cost per kw.-hr.
April	15080	756.81	300	456.81	$0.03
January	18450	936.26	470	466.26	$0.0252
October.	17810	884.76	300	484.76	$0.0328
July	12060	680.26	200	480.26	$0.04

Cost of plant $12,000. Fixed charges per kw.-hr. approximately ¾c.

Loft building.—185 by 200 ft. (56 by 61 m.) 12 stories and two basements.

Month	Kw.-hr.	Tl. cost	Basic cost	Mfg. cost	Mfg. cost per kw.-hr.
April	36930	1830.25	750	1080.25	$0.029
January	41950	1841.82	950	891.82	$0.0212
October	39480	1643.07	750	893.07	$0.0226
July	31800	1543.04	650	893.04	$0.0281

Fixed charges: ½ cent per kw.-hr. Plant cost, $20,000.

Apartment house: (free light); 36 apartments, high class refrigeration; best service.

Month	Kw.-hr.	Tl. cost	Basic cost	Mfg. cost	Mfg. cost per kw.-hr.
April	17450	1359.86	1016.85	343.01	$0.0197
January	21620	1360.84	1052.29	308.55	$0.0142
October	13500	1208.67	900.75	307.92	$0.0228
July	9350	1074.03	709.82	364.21	$0.0389

Apartment house: (Electricity sold to tenants; 87 apartments; high class refrigeration; best service; large quantity public lighting.)

Month	Kw.-hr.	Tl. cost	Basic cost	Mfg. cost	Mfg. cost per kw.-hr.
April					
January.	18154	2224.59	1749.18	475.29	$0.0261
October.	14885	1920.56	1507.34	413.22	$0.0278
July	11254	1731.54	1226.66	504.88	$0.045

These items are all higher than usual because last year the plant was completely overhauled, new plates installed in storage battery, new condenser for refrigerating plant, new hot water tank etc., all of which is charged off during ten months from date of expenditure.

Office building: 100 by 100 ft. (30 by 30 m.) 12 stories; tungsten lighting; four elevators.

Month	Kw.-hr.	Tl. cost	Basic cost	Mfg. cost	Mfg. cost per kw.-hr.
April	14600	738.15	365.62	372.53	$0.026
January	18310	714.39	458.40	255.99	$0.0142
October	15060	669.69	355.03	314.66	$0.021
July	11590	693.17	250.00	443.17	$0.04

Office building: 140 by 70 ft. (42.6 by 21 m.) 10 stories.

Total kw.-hr. 340,000 of which 88,817 were used mainly for driving an electric pump for operating two high-speed plunger elevators. 255,788 kw.-hrs. for lighting.

Total cost per year	$8,070
Basic cost (estimated)	3,200
Cost of electricity	4,870
Manufacturing costs per kw.-hr.	1.43 cts.

Manufacturing Plants.

Locomotive Works—oil engines.

	Cents
Total cost per kw.-hr. on 225 h.p. set (including 0.233 cent. for fixed charges)	0.74
5,300 hours a year at full load	
Shop time 6,500 hours.	
With load factor another year after panic, of only 24 per cent. cost per kw.-hr. was increased to	2

Malleable Foundry: Producer Gas Plant.

	Cents
Total cost per kilowatt hour including fixed charges approximately	1.71

Hardware: (Steam plant condensing.) These figures include interest and depreciation and are given through courtesy of Mr. T. Hoops, jr., Superintendent of Wilcox Crittenden & Co., Middletown, Connecticut.

1908.

Month	Kilowatts	Cost
May	23,970	0.01986
June	27,760	0.01733
July	29,600	0.01602
August	27,530	0.01736
September	27,830	0.01601
October	26,180	0.02095
November	22,360	0.02289
December	24,960	0.02164

Silk Mill Producer Gas Plant. (New York City); 150 by 100 ft. (45.7 by 30 m.) 4 to 5 stories high.

In week's run of 56 hours	4208 kw.-hr.
	Cents
2.6 pounds of pea coal per kw.-hr. approximate cost, including fixed charges	2¼

Department Store: 2,500,000 kilowatt hours.

Cost per kilowatt hour	1.34

Hotel: (based on figures given by chief engineer).

Cost of operation with plant	$33,285.71
Cost of operation without plant	
Cost exclusive of electricity purchased	25,779.71
Cost of making electricity	7,407.00
Cost per kw.-hr.	between 6/10 and 7/10 cents.

Hotel: 300 rooms; 12 stories; 240,000 kw.-hr.

Total operating cost	$12,800
Basic cost (based on operation before plant was was installed)	8600
	$4,200
Cost per kw.-hr.	1.75 cents

Table of Cost per Kilowatt Capacity.

(Based on personal experience in New York and vicinity.)

	Per kw. of plant capacity.
Boilers (erected and set in masonry).	
Horizontal-tubular	$14— $18
Water-tube	15— 20
Steam engines:	
High-speed, simple direct-connected	20— 25
Medium-speed, compound non-condensing direct connected	28— 35
Low-speed, compound condensing, belted.	20— 25
Low-speed, simple, belted	25— 30
Gas engines	50— 60
Oil engines	75— 85
Gas producers	15— 20
Dynamos:	
Direct-connected to high speed engine	13— 16
Belt-connected to engine	12— 15
Direct-connected to corliss engine	16— 20
Switchboard	5— 10
Foundations	5— 10
Steamfitting—including auxiliary apparatus—such as feed heater, grease separator, exhaust head, tanks, covering, etc.	20— 30

The figures of installation cost have been published by me before and I use them in estimating and find them to be closely correct for New York City.

I hope that these figures, together with the other data presented will be of use and will also serve as a basis for discussion and presentation of other facts and figures.

WATER SUPPLY OF REGINA.

Some time ago the municipal council engaged the services of Mr. R. O. Wynne-Roberts to report on the domestic water supplies available in and around the city of Regina.

Mr. Wynne-Roberts' report has been submitted to the council and shows that seven million gallons of water are available daily for Regina, providing the waterworks system is materially extended at a cost of $1,106,045.

By 1918 the 7,000,000-gallon daily supply would be insufficient for the demand, if the growth of the city continues at its present rate. By that time Regina will have to look to the Saskatchewan River, or Long Lake for a supply.

The report gives details on all available sources within a radius of fifteen miles of the city, as well as details of the foregoing expenditure which is as follows:—

At Boggy Creek: New pump well, $7,271; manhole, No. 1, $16,406; manhole, No. 1, $6,880; manhole, No. 2, $2,750; pump well to steam pump well and Zimmerman Br., $47,889; laterals, pipe lines, $2,000; two meters, at pump well, $2,000; one meter, at power house, $1,000; sinking wells and pump at Boggy Creek, $2,000; making a total of $88,206. The works outlined, in conjunction with those already in use, are contemplated to give a daily supply of 3,000,000 gallons.

Outlining a comprehensive Eastern Regina water scheme, it is pointed out that it has for its object the connection of several water-sheds into one trunk main, which would be conducive to economy. The works are designed so that they may be carried out in sections, as the council deems necessary.

It is proposed to lay a collection main in the ravine lying east of Rastadt to open out the springs and convey the water in vitrified pipes to main springs draining the water into the collecting mains. At a point where the collecting mains will terminate it is proposed to install a gasoline engine and pump with pump house and residences for men. The water will be collected in a suitable well and pumped

through a steel main about eight and one-half miles in length, along road allowances, and there discharged into a circular reinforced concrete reservoir. Although the supply is dependent to a large extent on wells and underground water-sheds, certain sprinks will play an important factor if this report is adopted and carried out.

The estimates of the cost of the proposed works are placed under four heads, as follows:—

Silver Stream Section.—Pipe lines, $274,740; 400 h.p. engines and 7,000,000-gallon pumps, $20,000; pump well, $20,000; engine house, $2,000; cottages, $4,000; meters, water level recorders, $8,000; contingencies, $32,874; making a total of $361,614.

Slough Creek Section.—Pipe lines, $163,056; meters, $6,000; contingencies, $16,950; making a total of $185,961.

Hicksvale Creek Section.—Pipe lines, $270,400; two 1,000,000-gallon reservoirs, $35,000; meters, $6,000; turbine pumps and station, $6,000; cottage, $2,000; contingencies, $31,940; making a total of $351, 340.

Rastadt Springs Section.—Pipe lines, $179,300; engine, pump and building, $6,000; cottage, $2,000; meter, $1,000; contingencies, $18,830; making a total of $207,130.

It is proposed to deliver the water to the city through a steel main to be laid from Silver Stream along Dewdney Street and connect to the city water mains at a convenient point. It is proposed that the city water pressure should be maintained at about 65 pounds per square inch—that is about 150 feet head, which will be sufficient to provide an ample supply to the highest building in the city. The system would be capable of supplying water under a greater pressure when necessary

It is estimated that the combined scheme and watersheds described will probably yield a total supply of about 7,000,000 gallons per day. It is pointed out that it would be advisable to install self-recording meters on the various sections.

THE ST. JOHN VALLEY RAILROAD.

The contract for the construction of the above mentioned railway, when completed, will be a great impetus to commerce in the Maritime Provinces, particularly New Brunswick. The route, as described in the contract, is, briefly, from a point on the National Continental Railway at or near Grand Falls, via Centerville and Lakeside, to Woodstock, thence by the River St. John to Fredericton and Gagetown, thence crossing the St. John River at or near the Mistake, thence crossing the Kennabacasis River at or near Perry's Point, and thence to the city of St. John, the whole representing 208 miles. It is provided that the divisions from Fredericton to Woodstock and Woodstock to Centerville shall be completed on or before November 1st, 1913, and the whole road is to be completed on or before November 1st, 1915. The Provincial Government guarantees the bonds of the company to the extent of $25,000 per mile.

The road now under contract is one link in a chain of railroad development. Logically connected with the St. John Valley is the proposed line known as the St. John and Quebec Railroad, which it is planned to cross the State of Maine from a point of connection with the Aroostook Valley Road at Washburn to the western boundary of the State, from which point a line is chartered by the Dominion Government to run to the St. Lawrence River, fifty miles.

When these two sections of road are completed, the distance by rail from Quebec to St. John will be 370 miles, and a very important saving will be effected in transportation in these portions of the Dominion. Mr. Ross Thompson is the chief engineer, and Mr. S. B. Wass the assistant chief engineer of the company.

FORESTRY OPERATIONS ON THE PENNSYLVANIA RAILROAD.

An important work of interest to railway officials and others is the conservative management of the Pennsylvania Railroad timbered lands. The logging operations which have been conducted by the company's foresters during the last three years cover a total area of about 1,200 acres and form only one of the means which are being used by this railroad to solve the problem of procuring ties and other timbers. It has been in use for three years, during which time 2,600,000 board feet of lumber and 15,000 ties were procured from woodlands managed by the foresters. The tracts on which they are applying the principles of silviculture include small areas along the right-of-way which have no value to the company except from the timber which is growing on them, and the more extensive areas of land which are the catchment basins for the mountain reservoirs which supply water for locomotive and shop use.

Logging operations as carried on by the foresters have in view the best utilization of the standing timber and the conservation of the supply for future operations. Although the aim is to leave each tract logged in more productive condition than before, each case presents its own peculiar conditions, and must be considered as a separate problem. On many unmanaged timber tracts frequent fires have added to the injury caused by partial cuttings. In extreme cases the result of such fires and cuttings is that there are no young trees which are worth leaving and the mature trees are badly damaged. Under such extreme conditions the area, as a rule, would be cut clean and a complete planting made. The other extreme condition evists when the area has been free from fires and cuttings and the growth is so well graded in age that it is possible to cut out matured trees and still leave sufficient young growth to stock the area. The most prevalent condition, however, lies between these two extremes, and the methods adopted under such conditions are well illustrated by the work done on the Brush Mountain tract near Altoona, Pa., according to the Railway Age Gazette. This tract includes about 700 acres in the drainage basin of the reservoirs which store the water for use in case of fire at the Altoona shops. Forest growth conserves and purifies the ground water supply, and in order properly to care for the timberlands in drainage areas the officers responsible for the water supply were glad to avail themselves of the services of the company's foresters. The tract under management lies in a basin-shaped valley known locally as the "Kettle." The slopes are steep, with a range of about 400 ft. in elevation. The forest on most of the area was second growth in blocks of even age from six to eighty years old, resulting from fires and partial cuttings. There were also some virgin trees which had been left because they were not merchantable. Three types of timber are distinguishable. The bottom land bears hemlock, white pine, black birch, red maple, white ash, cucumber tree, tulip, basswood and black ash. As this low ground is continually moist, fires have never been able to run over it, and on that account the reproduction is good. The slopes, which include most of the area, have white oak, red oak, scarlet oak, black oak, chestnut, beech, black birch, white pine, pitch pine, black gum and pignut hickory. Fires have repeatedly run over these areas, with the result that there is very little ground cover and reproduction is mostly of sprout origin. The ridges are dry and the scattered timber was stunted and of poor quality. The principal species are chestnut oak, black oak and pitch pine. The reproduceion is so poor as to be hardly worth considering. Many trees on the tract had been seriously damaged by fire and wind, and many

were dead or dying, so that much of the lumber was fast decreasing in value.

On account of the mutilated condition of this forest a very heavy improvement cutting was necessary. The intention was to remove everything that could possibly be removed without interfering with the water conserving value of the property or reducing the productive capacity of the land, and ultimately to secure a stand which would produce timber usable by the railway. To these ends there were removed in the cutting all mature, damaged and dead trees of all species; all trees of merchantable size, except where needed for reproduction; and every tree of the following species: gum, scarlet oak, birch, sassafras, ironwood, dogwood and witch hazel. The foresters of the company personally marked all trees for removal. In this marking a short-handled axe is used to blaze the trunk breast high and just below stump height. To identify the mark, a sharp blow is struck in the bare spot with the keystone brand of the head of the

Locust Grove, Planted in 1902.

axe. In the process of marking, many barren spots were found which had been so badly burned that there could be little or no natural reproduction of desirable species. On these areas it was decided to plant three-year-old Scotch pine seedlings where the soil is not too rocky and to sow white pine where there is not sufficient soil for the Scotch pine. A contract was let to an experienced woodsman for all logging on the tract, the contractor agreeing to deliver the manufactured timber on cars at Altoona. This contract also covered taking tanbark and the other by-products, except charcoal, which was covered under a separate contract. The tanbark was taken first, the work beginning early in the spring. Only hemlock and chestnut oaks were usable as tanbark, and the trees which were cut for their bark were allowed to remain where they fell until the beginning of the logging. For getting out the sawed timber, a portable sawmill having a capacity of about 5,000 board feet a day was used by the contractor. The foresters in charge of the work at first designated to the contractor what form of timber should be made from logs of a given species and size, but as the contractor had had considerable experience in this work and was intelligently interested in this conservative logging, the matter was left largely to his judgment with frequent checks by the foresters. The contractor was so well satisfied with the results of the marking that he has since sought to employ the company's foresters to mark trees on his own land. In general, ties were made from white oak and chestnut oak trees of a diameter which would just make one tie, as it was more profitable to saw logs large enough to make two ties into bridge timbers, crossing planks or smaller sticks. The contractor was required to avoid injury to young trees throughout the work by so felling trees as not to strike any trees not intended for removal, by not cutting saplings of desirable species for use in logging operations, and by not locating roads through young growth. All stumps were cut low, the rule being that the stump of a sound tree should not exceed in height half the diameter of the tree at stump height. The surface of the stumps was left smooth and in good condition so that desirable sprouts would be more readily produced. Branch wood and refuse was cut so as to lie close to the ground and thus rot more readily. Since cordwood was not readily saleable in the vicinity, it was necessary to make charcoal from the unmerchantable timber.

Both the contractor for the logging and the one for making the charcoal agreed to exercise every possible care in preventing fires and in fighting them when once started. This is the most important provision that can be made in managing timber land. During dry weather a man was kept patrolling the tract continually, and in case of an alarm of fire the contractor was required to set every man in his force to fighting the fire.

Up to the present time about 1,200,000 board feet of lumber, 5,000 cords of charcoal woods, 90 cords of paper wood, 130 cords of tanbark and 189,000 lath have been made from this tract. Of this amount the following was taken by the Pennsylvania Railroad:

Lumber—		
Oak	110,000	board ft.
Pine	124,000	" "
Hemlock	71,000	" "
Chestnut	3,000	" "
Crossing plank—		
Oak	33,000	" "
Chestnut	6,000	" "
Ties—		
Cross	678	
Switch	70,000	board ft.
Bridge	57,000	" "
Fence posts	2,971	pieces
Charcoal	153,404	bushels.

The products that could not be used by the railway were sold to outside parties. All products taken by the company are charged at market prices, and on this basis the operations on this tract have netted a profit of over $12,000 to date, including in the expenses all supervision and technical administration of the work.

The cost of practising forestry in this manner is calculated by the department at about five cents for each thousand board feet. Since the net profit on the 1,200 acres logged has averaged about $23 per acre (stumpage not charged), and this is typical second growth land which has been considered of little value, it is evident that if the example of conservative logging set by the railway were followed by other land owners in the state the amount and value of forest products, both present and future, would be greatly increased.

The company's purchasing agent always gives the forestry department a chance to fill a requisition for lumber before an attempt is made to buy it elsewhere. If any of the material needed can be supplied from the company's tracts the order for it is placed with the forester. In order to provide seedlings for planting the company conducts a nursery at Morrisville, Pa., where commercial trees are grown and ornamental stock is carried for use on the system. The total area under cultivation is 38½ acres and the annual capacity is about one million trees. Comparing the cost of producing the trees at the nursery with the market price, the net saving to the company for the year 1910 was about $6,000. The planting of trees on unused land has been

carried on since 1902. During the nine years up to and including 1910, there were set out 4,099,524 trees. This planting has been done on tracts of various sizes and under various conditions. Whenever a tract is turned over for forestry purposes a careful examination is made to determine how it can best be used. If it is already wooded the timber is inspected, and if the stand is sufficiently valuable the tract is carefully logged and conservatively managed. If it must be cut clean, or if it is already a clear area, the advisability of planting it is considered. If it is to be planted, the species which will grow best in that soil must also be decided on. The planting may be done either in the spring or fall, preferably in the spring. This work is done by squads of men who are employed locally. They work over the ground in two rows, the men in front cutting the sod and digging holes with mattocks, and the men behind, who carry the seedlings in buckets partly filled with water, planting them in the holes. The trees are set in rows, the location of each tree being determined by the planters by sighting stakes or by following stretched lines. Under favorable circumstances a squad should plant 400 trees per man per day. To grow tall and straight trees desirable for timber is is necessary that the seedlings be planted close together, the approved spacing in most cases being six feet in both directions. After several years this growth may require thinning if the stand is good, although the natural suppression of a considerable number of the seedlings must be expected. Along all such plantations which adjoin the right of way a fire line is kept plowed to guard against the spread of fire from locomotive sparks. Most of the older plantations are of black locust, and it is to be regretted that this species is being attacked by borers with considerable damage to the young trees. The borers attack both good and bad trees, and, although they do not kill the trees, the holes they make cause many of the trees to break and to a marked degree weaken the timber which can be made from the tree. The locust leaf miner is also attacking these plantations, with the result that the growth of the trees is retarded through lack of nourishment, since the leaves cannot perform their functions after they are attacked by the miner. Although the locust grows well in Pennsylvania and makes desirable trees, posts, etc., it does not seem practicable to continue its planting for these purposes until some method can be devised to prevent the damage by these insects.

Various lines of experimental planting are attempted from time to time. As an example of this class of work, two double rows of evergreen trees were planted near Glen Loch, Pa, in 1910, to serve as a snow fence. The wooden snow fences commonly used require considerable maintenance, and it is thought desirable to substitute growing evergreen trees where conditions are favorable. Their use, however, requires a wide space between the track and right of way line. In the planting made, the first row of trees is Scotch pine planted 100 ft. from the track, while the outer row, of Norway spruce, is planted along the property line. To save expense, small trees were used in this planting, but it is thought they will be large enough in a few years to drop the snow behind them successfully.

ELECTRIFICATION OF BRITISH RAILROAD.

The consulting engineers of the London, Brighton & South Coast Railway are preparing plans for the further electrification of the company's suburban services and the extension of the electrification schemes to the main line.

MANUFACTURING BUILDINGS.

The following data appeared in an address by Mr. E. H. Darling, assistant engineer of the Hamilton Bridge Works Company, Hamilton, given before the Engineering Society of the University of Toronto. The remainder of the address was printed in the November 9, 1911, issue of The Canadian Engineer under the title of Preliminary Problems in the Design of Manuafacturing Buildings.

1. Slow burning or mill construction.
2. Fireproof construction.
3. Steel frame construction or mill buildings.

Slow burning or mill construction is simply a special class of timber work. Such a building will have heavy brick walls with the interior columns, beams and floors of massive timbers so disposed as to present the least possible opportunity for the spread of fire. The columns are made of single timbers, usually square, capped with a corbel or short beam which forms a seat for the column of the next floor above, and supports the cross beams which carry the floor. This corbel may be replaced by a steel or cast iron cap which is more reliable when the loads are great. The cross-beams are also heavy single timbers, and on these are laid 2-in. by 4-in. or 2-in. by 6-in. pieces set on edge and spiked together, so as to form a floor 4 in. or 6 in. thick, as the case may be. A hardwood wearing floor 1 in. thick is usually laid on this. Note the absence of all joist and any thin projecting woodwork which might easily catch fire. In case a fire should start, the thick floors would tend to confine it to one story and the heavy beams and columns would burn slowly, thus giving the fire department a chance to put it out before it destroyed the whole building. This construction is only effective, however, when used intelligently, for unless all the many rules for preventing the spread of fire are carefully observed, the result may be disastrous.

The roof of such a building may be constructed like the floor, or, if the span between the rafters is not too great, matched sheeting may be used. This is covered with a felt and gravel roofing material or some one of a score of special roofings which will resist the attack of fire.

The cost of long timber of large cross-section practically limits the length of beams to somewhere between twelve and sixteen feet. This means that in a wide building there will have to be many columns, which take up room and interfere with the arrangement of machinery.

2. Fireproof Construction.—While there might be a difference of opinion as to how far it is expedient to go in making a particular manufacturing building fireproof, it is well understood that, if a building is to stand all the vicissitudes of a conflagration, it must be made entirely of brick, concrete, terra-cotta, and steel, the steel to be well protected from the direct heat of the fire.

It is in office buildings, hotels and tenament houses that fireproofing principles have been most extensively applied, and the manufacturer who requires a building of somewhat similar form will use similar methods of construction, adapting them to his special needs. Reinforced concrete may be used entirely for floors, beams and columns, or steel may be used for the beams and columns to form a framework to carry the floors. In this case the steel must be covered with at least 1½ in. to 2 in. of concrete.

Terra-cotta is being introduced for use in certain classes of manufacturing buildings, but, being more or less brittle and not suitable to withstand vibration and shocks, its use is limited. Its most extensive use is in the form of tile for roofs, where its lightness is an advantage.

3. Steel Frame Buildings.—This class of construction is used for rolling mills, machine shops, foundries, etc., which are usually classified under the head of mill buildings. Its distinctive feature is the steel skeleton which forms a frame to support the roof and side covering. This covering is usually corrugated iron, galvanized and sometimes painted also. When so constructed, the building is entirely metal, even the window sash may be made of steel. The result is that it can stand an immense amount of rough usage and unless filled with inflammable material, is not easily injured by fire, nor is it effected by the elements provided it is regularly painted and properly cared for.

But in a building of this class its function as a protection from the weather is really secondary, its main duty being to sustain cranes, hoists, and other machinery. In fact the structure is a huge machine itself. In its design the same engineering principles are applied which are used in the building of steel bridges. Every possible stress is estimated and provided for. Often the analysis of these stresses is made extremely complicated by special combinations of traveling cranes, bins, machinery and wind pressures, but all must be taken care of if the building is to be rigid and safe.

Each of the above three types of construction has its own special advantages, and they are often combined in various ways to obtain a desired result. The slow-burning construction has the advantage of being cheap in first cost. Until recently it had a further advantage of time in rapid erection, but it is now so difficult to obtain first-class lumber and the cost is such that these advantages are lost. The commercial size and length of timbers obtainable also limits the span of beams and the spacing of the columns, as explained above. However, for factory buildings, such as woollen and cotton mills, etc., where the machinery is small and light, this feature is not necessarily objectionable. But the one which weighs heaviest against it is its inflammability. That means, for one thing, high insurance rates and the ever present danger of fire.

The first natural variation, made in slow burning construction, is the substitution of steel for beams and columns. This permits longer spans for the beams and heavier loads on both beams and columns. Steel columns are often put in the outside walls as well. The steel work is then self-supporting and may be erected complete independently of other trades. As these columns relieve the walls of all beam loads, and also reinforce it, the walls may be made much lighter than would otherwise be permissible. As a fire risk, however, this combination is considered inferior to the slow burning construction. Steel becomes soft at a red heat and is entirely unable to resist stresses. If, when thus heated, a stream of water is directed on it, it warps and twists. While an ordinary fire will not actually destroy the metal, the physical state of the material may be so altered as to be entirely unreliable. Consequently its salvage value is only what it will bring as "scrap."

In buildings of three or four stories, round cast iron columns are sometimes substituted for the rolled steel. If neatly cast, they present a better appearance than the built-up steel column, but unless designed by one accustomed to working with cast iron, and unless they are most rigidly inspected, there is always a very great uncertainty as to their strength. Apart from this unsatisfactory feature, cast iron has the advantage over steel in being better able to resist heat. They will usually cost more than the steel column.

If, in buildings where steel is used, it is protected by about two inches of concrete, practically all the risk of damage from fire is eliminated. This is rarely, if ever, done if the floors are of wood, for if the fireproofing is carried to this extent, it only means one step more to make the building entirely fireproof. Wood floors, however, have this advantage, in addition to being cheaper. It is much easier to cut openings or bore holes in them than it is in concrete, and that is an item worth considering where there is likely to be much of this work to do.

As stated above, buildings which are to be fireproof must be constructed entirely of reinforced concrete, or steel covered with concrete or terra-cotta. Buildings of this type have come through conflagrations and earthquakes with credit. The one thing to remember in using reinforced concrete is that there must be no slighting of the work whatever. To get a good job, it is sometimes a continual fight against ignorance and carelessness, and sometimes dishonesty. A mistake once made is very hard to remedy. A defect may easily escape notice until a catastrophe occurs. Many accidents have already been recorded and there have probably been many more that have never reached the ears of the public. There are large new buildings which stand finished, but vacant, and condemned.

That this blot against reinforced concrete is not fair to this construction, is proved by the fact that many engineers, especially European engineers, get quite satisfactory results although they use much higher unit stresses than the average. The secret is that they take more time for the work, and give it more rigid supervision.

By using a steel frame work for a building, much of the uncertainty as to its safety may be done away with. There is also a saving of head and floor space, as the steel beams and columns are smaller than those of reinforced concrete. In a building of many stories a few inches to each story adds up to quite an item. The columns in the lower stories become so large that, as one writer has put it, the building resembles the Egyptian pyramids—most of the room is on the outside. Nor are engineers agreed as to how concrete sets when poured wet in large masses.

There are other objections to the use of reinforced concrete for certain classes of manufacturer's buildings. Where it is necessary to make frequent changes, alterations and repairs and, in fact, in any structure that is not intended to be permanent for many years, it becomes very costly. When it has outlived its usefulness it is expensive to remove and the materials have little or no value.

Referring to steel frame mill buildings, structural steel has other useful properties in addition to those referred to above. Such a building is not limited to any size, shape or form within reason. Any loads can be taken care of with certainty. The erection of the frame usually goes ahead very rapidly, forming a scaffold for other work. Steel must, however, be frequently painted if exposed to moisture or corrosive gases to prevent rust and corrosion.

REINFORCED CONCRETE.

Mr. G. C. Workman, M.S.E., M.C.I., read an interesting paper recently on "Some Recent Works in Reinforced Concrete," before the Concrete Institute of England.

The object of the paper was to describe a few of the numerous works recently executed in reinforced concrete, and to bring out some of the more interesting features of each particular case, and to show how various difficulties had been overcome. The author said that, owing to modern requirements, there was a growing tendency for the various barnches of engineering to become specialized in order to obain by a continual study of each subject, the maximum amount of economy and efficiency.

It was for that reason that a certain number of engineers had become specialists in the designing of reinforced concrete, each one adopting the particular method of reinforcement which he thought best suited for the purpose.

Personally, he had for the past ten years been identified exclusively with the "Coignet system," which was one of the first rational and scientific methods of reinforcing concrete.

As there were a certain number of different ways of reinforcing concrete, he first of all gave a short description of the methods employed in the various works which he described.

Commencing with the beams, which were usually considered the most important part of a structure, round bars of mild steel were used, the diameter varying between ⅜in. and 1⅝in. The steel frame-works were designed in such a manner as to form independent units which could be easily made on the site and placed on the centering when required. In some cases the tension bars for the lower portion of the beams were all straight with a corresponding parallel bar in the upper compressed portion of the beam; a mechanical bond between the upper and lower bars was provided by means of stirrups made of round mild steel wire varying between 3-16in. and ¼in. diameter. These stirrups had their ends bent over the top bar, and they were fastened by means of annealed wire to the main bars so that their position could not be changed during the process of concreting. The spacing of stirrups was, of course, varied in accordance with the shearing stresses.

Another method of preparing steel frameworks consisted in grouping together seven tension bars of comparatively small diameter; six of these bars were bent upwards at an angle of forty-five degrees and hooked over a longitudinal top bar ½ in. diameter in such a manner as to form a kind of truss. Additional stirrups were also provided, as in the first method described, to counteract any extra shear.

This last arrangement had the advantage of being more economical than the first one because the section of steel in tension was made to decrease gradually towards the points of support where the bending moments were less, the extra steel being used to resist shear or diagonal tension.

In regard to shear he pointed out that in the first method, comprising vertical stirrups and horizontal bars, the vertical shear was taken up by the main bars and the horizontal shear by the vertical stirrups, whereas in the last-mentioned alternative the vertical and horizontal shear, or, in other words, the diagonal tension, was counteracted by the bars bent at an angle of forty-five degrees.

The longitudinal top bar was, of course, necessary for the preparation of each unit. This bar was very useful to suspend the framework in the centering, and as it was situated in the upper portion of the beam it increased the resistance to the compression. The upper ends of the stirrups and shear members was secured by means of hooks to the top bar. That precaution was in accordonce with the new rules of the Joint Committee of the Royal Institute of British Architects, which state that in every case care should be taken to bend or otherwise secure the ends of the rods to prevent them from slipping in the concrete.

The negative bending moments in beams were counteracted by joint bars of sufficient length.

In many of the buildings the steel frames of the pillars were made horizontally and placed in position in the casings when required. The frames were composed of main bars bound together either by 3/16 in. or ¼ in. wire, forming spirals or horizontal ties with a pitch of about 6 in. The object of these ties was not so much for strength as to keep the vertical bars in their proper position during the concreting.

The reinforcement of rectangular floor slabs was provided by simply placing principal bars of about ½ in. to ⅝ in. diameter in the smaller spans and ¼ in. distributing rods at right angles to the others, so as to form a mesh, the bars of which are bent up gradually over the beams in order to resist contraflexure.

As previously mentioned, round bars had been used throughout because they had the advantage of being easily procurable in the open market, and because that section produces the minimum amount of contact between the various bars forming the units. It was obvious that flat surfaces of contact between bars should as much as possible be avoided because rust was likely to develop in such places, and that defect might ultimately become a source of danger. Another reason for round bars being favored was that they offer a better surface of adhesion than any other available section.

BOX LUMBER IN CANADA—1910.

The reported consumption of lumber for boxes and shooks in Canada during 1910 was over one hundred and fifty-eight million feet, valued at two million two hundred and seventy-three thousand dollars. These statistics have been compiled by the Forestry Branch of the Department of the Interior from reports received from one hundred and two box factories, over one-half of which are in Quebec. Seventy million feet of lumber or forty-five per cent. of the total was used in Quebec. Ontario used sixty million feet or thirty-eight per cent. of the total and the remainder was used in the provinces of New Brunswick, British Columbia, Manitoba and Nova Scotia. Pine, the chief species used in Ontario, formed forty-five per cent. of the total box lumber and cost only $13.93 per thousand. This comparatively low price for pine, indicates that with this more than with any other species, mill waste and cull lumber is being used in the manufacture of boxes. Spruce in 1910 was used in every province in which boxes were made, and formed forty-one per cent. of the total. The cost was $13.83 per thousand or twenty-eight cents more than the average mill run price, so that manufacturers using spruce demand the finest quality. The remaining fourteen per cent. of the total was comprised of fourteen other woods, of which hemlock, basswood and balsam were the chief. The most expensive box-wood used was a million and half feet of Douglas fir at $23.00 per thousand in British Columbia. Balsam fir used in the three eastern provinces was the cheapest box-wood reported in 1910 at $8.94 per thousand. It is a wood light in color, tasteless, fairly strong, and its use in the manufacture of boxes should be encouraged.

FORESTRY IN EUROPE.

The productive forest area in 1908 in the Grand Duchy of Hesse in Europe amounted to 182,263 acres. In general the standing timber is composed of sixty-nine per cent. hardwood and thirty-one per cent. coniferous forest. The fir ranks first among the coniferous species. The total yield of lumber in 1908 was 4,575,000 cubic feet. Refuse in so far as it is not suitable for lighter lumber, such as laths or for pulp, is used for firewood. The expenditures for salaries, forest cultivation and road building amounted to approximately $754,000, and the total gross income (from lumber and firewood) was $1,161,931. The capital represented by the forests ($52,665,354) brought interest accordingly at 2.21 per cent. Where intensive forestry of this kind is practised, forest fires are unknown. Sufficient money spent on Canadian forest reserves would greatly reduce the fire danger, maintain an adequate lumber supply for the country and in time become a source of revenue to the government.

Metallurgical Comment

T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

CAST IRON FOUNDRY PRACTICE.

The fight for the adoption of scientific metallurgical management in the cast iron foundry is one that still continues. Large strides have been made toward better conditions. Foundry superintendents are gradually discarding the old unscientific methods of judging the grades of pig iron. Greater reliance is being placed upon chemical analysis. Apathy, on the other hand, still contests the field with a stubbornness that brands it as having its source in ignorance.

Without the aid of chemical analysis, the great accuracy attainable in the making of given grades of steel wherein the carbon content, for instance, may be regulated down to hundredths of one per cent., could not exist. Metallography, a science that may be termed as comparatively new, has been readily and quickly adopted by the steel maker. In fact, history shows that the manufacturer of steel has been quick to reach out and call to his aid any scientific development that could be reasonably called practical. In this respect, the steel maker is far in advance of the cast iron manufacturer. That this is practically due to the fact that cast iron foundries are usually very small in comparison with the huge steel plants, has to be acknowledged; but, nevertheless, there undoubtedly has been and still is to a certain extent, an apathy on the part of the cast iron founder that is difficult to explain.

To take the case of chemical analysis: The wide-awake foundries not only buy their pig iron by analysis, but they also check the product when received. Now and again, though, one finds examples of foundries that are making a commodity, the specifications for which do not call for any particular analysis of iron, perhaps, merely specifying a certain limit of strength. In cases such as these very little attention is paid to the analysis of the pig iron used. To suggest to the foundry manager that it woud pay to check up the analysis even under such circumstances, is, in most cases, superfluous. Yet it would not be difficult to find cases where one-quarter of a day's output could often have been saved had more attention been paid to the iron being used. The fact that **metallurgical supervision pays always** does not seem to be grasped.

There is another factor besides the involved cost to the manufacturer that tends to perpetuate these conditions. If engineers would insist upon being furnished with chemical analyses as well as physical tests for cast iron **in all cases,** a large step forward would be made. In reality, as far as cast iron is concerned, physical tests on bars generally mean very little, as no attention is paid to the rate of the cooling of the bar, a point of extreme importance in determining the ultimate nature of the iron.

As with the making of steel products, so with the manufacture of cast iron; the man who does not recognize the advantages of scientific metallurgical supervision, is being gradually placed at a disadvantage, and the engineer who has to do with cast iron can help materially to bring about such a desired state of affairs by following the course as suggested above.

IMPROVEMENTS AT NOVA SCOTIA STEEL AND COAL COMPANY'S PLANT.

During the year 1911 many important improvements and betterments were effected at the various plants of the Nova Scotia Steel and Coal Company. Processes of manufacture absolutely unique in Canada were adopted, important departments brought to a point where they stand second to none in the world and generally the company maintained its position as the pioneer of the Canadian steel and coal trade.

The most important additions during the year were the installation of a fluid steel compression plant at the open hearth department, Sydney Mines, Cape Breton, and the substitution of hydraulic presses for steam hammers in the forging department at New Glasgow. In taking this step, "Scotia" has again been the first to bring the latest European methods of steel making to Canada and in consequence is prepared to handle a class of profitable business which no other Canadian company will be able to deal with until they adopt similar machinery.

The increased tonnage of finished product arising from recent additions to the rolling mill equipment necessitated the substitution of a 34-inch blooming mill for the old 26-inch mill which was no longer able to furnish the billet tonnage required by the various finishing departments. Many other improvements, but of a somewhat minor nature, designed to effect working economies in the various departments were also installed and the plant generally kept in a very high state of efficiency.

The fluid steel compression plant is designed to improve the quality of the ingots by expelling the gases generated during conversion and pouring, thus eliminating blow holes and other similar flaws. The process, which is fully patented in all the principal countries of the world, will be worked under arrangements with the inventor, M. Harmet, of St. Etienne, France, whose experience and advice are at the disposal of the company. The plant consists of a group of four hydraulic presses capable of dealing with ingots weighing both three and five tons and a mammoth single press capable of compressing ingots of twenty tons and upfards. The machinery is exceedingly massive, several single pieces weighing 80,000 lbs. each and both presses are capable of exerting a pressure of 4,000 tons on the steel while still in the fluid state.

An entirely new ingot car casting and electric stripping plant has also been installed in the open hearth department which it is expected will effect considerable reduction in costs.

During the last two or three years the New Glasgow works have been practically reconstructed and are now perhaps the most efficient in their particular lines of manufacture in the Dominion. The process of modernization was greatly enhanced this year by the erection of the hydraulic forge and new engineering shops. These cover an area of 40,000 sq. feet and are of steel, brick and concrete construction. The hydraulic forge plant contracted for in Europe some nine months ago consists of two presses, the smaller of 600 tons, the larger of 4,000 tons capacity. The latter will be able to deal with ingots weighing up to sixty tons. The presses are operated on the steam hydraulic principle, all the accessories being electrically driven.

To handle the ingots while being heated and forged in this department, two electric cranes, one of 60 tons and the other of 30 tons capacity have been installed. A 30-ton electric crane is installed in the engineering shop and a similar one in the ingot assembly yard.

The completion of this plant will place the Scotia Company abreast of any forge shops in Europe, probably in ad-

vance of any on this continent and will certainly enable it to undertake the heaviest work of this class which the growing demands of the Dominion will call for in a number of years.

Within a short time all the ingots produced at the company's open hearth plant will be rolled on the new 34-inch blooming mill now being installed. This mill, which was built by Lamberton and Company, Catebridge, Scotland, is complete with all the latest electric and hydraulic equipment and will add very materially to the efficiency of the plant. To drive it, a new engine of 4,000 horse power has been erected.

During the year there was completed the installation of an exhaust steam turbine electric plant. This consists of two units of 500 k.w. each operated by exhaust steam from the blooming and bar mill engines. The power thus generated will be used in all the various departments of the plant. Space is provided for a third unit which will be installed as soon as the electrification of the various departments has been completed.

The 800-foot shipping building erected in 1910 was completed during the year and has greatly increased the efficiency of this department. It is equipped with a 50-ton electric travelling crane having a span of 75 feet. The new manufacturing building in which will be housed the spike, rivet, bolt and nut, machinery steel, polished shafting and other smaller finishing departments has been largely equipped. A new department here is a pick-making plant which will produce all kinds of clay and miners' picks. Ample space for further extensions has been left in this department.

All the equipment in the new engineering shop will be motor driven and the entire building is designed along the lines of the greatest possible efficiency and economy. Among the machinery installed here will be one high speed 20 ft. by 6 ft. by 6 ft. Loudon planer; one Smith and Coventry 10-ft. boring mill; one 30-in. and one 21-in. Hulse lathe, two Bertram horizontal boring and drilling machines and one Dallett portable drill and shaft centerer.

THE INFLUENCE OF OXYGEN ON COPPER CONTAINING ARSENIC OR ANTIMONY.

The experiments described in this paper, by Mr. R. H. Greaves, B.Sc., were made to determine the influence of oxygen on certain mechanical and physical properties of copper containing either arsenic or antimony in quantities up to 0.5 per cent. A number of comparative tests in which the metals were cold-rolled down to 0.02 in., or drawn into fine wire, showed that with increasing arsenic, the metal may take up more and more oxygen without suffering deterioration in its capacity for rolling. This quantity of oxygen increases from about 0.05 to 0.2 per cent. as the arsenic increases from 0 to 0.2 per cent., then more slowly to about 0.28 per cent., with 0.05 per cent. arsenic. Above this point the malleability falls off, and with still more oxygen the metal becomes "cold-short." The action of oxygen on copper containing antimony is similar, but in this case a small quantity (about 0.1 per cent.) effects a distinct improvement in the malleability of the metal. The ductility was similarly affected by oxygen. Tensile tests on the case metals showed that increase in oxygen from 0.15 to 0.4 per cent. caused a rapid diminution in elongation; the effect on the maximum stress was not marked. Oxygen has little effect on the hardness (measured by the Shore scleroscope) until a limit is passed, depending on the arsenic or antimony present; above this, the hardness increases rapidly. This limit is at about 0.3 per cent. with 0.4 per cent. arsenic, but is less in presence of antimony. The first addition of arsenic or antimony decreases the hardness of copper containing oxygen. Measurements of electrical resistance show that oxygen diminishes the conductivity of copper containing arsenic, but increases that of copper containing antimony; the quantitive effect of the oxygen has not yet been determined. In an appendix, methods of determining oxygen in copper are discussed. Without denying the accuracy of other standard processes, the author suggests that oxygen may conveniently, and with a high degree of accuracy, be determined by reducing in hydrogen, and weighing the water formed.

*Abstract of a paper read before the Institute of Metals.

STASSANO ELECTRIC STEEL FURNACES.

In connection with the industrial development of the Stassano furnace, the following is of interest:

Since 1909 Major Stassano has been the sole owner of the patents and since then up to the present time he has made the following installations:

For the Societa Elba one 250-kw. Stassano furnace is in operation at Porto Ferrario and an 800-kw. Stassano furnace is to be installed in one of its works in Liguria.

For the Milan steel foundry, Fonderia Milanes d'Acciaio, one 250-kw. and two 100-kw. Stassano furnaces have been installed; for the J. J. Hoehn concern two 250-kw. furnaces, this plant being located at Odessa; for the Electro-Flex Steel Co., Ltd., of Newcastle-on-the-Tyne, three 250-kw. furnaces. A steel works is also being installed in Dunston-on-the-Tyne exclusively with Stassano furnaces.

After several years ago the Italian War Department had adopted the Stassano furnace for their Artillery Construction Shop. The Italian Navy Department will shortly likewise adopt it for the Navy Yards.

UNITED STATES GOVERNMENT REPORT ON THE COST OF STEEL.

The investigation shows that, as would be expected, the large companies have lower costs, partly due to superior efficiency, but also to monopolistic control, especially in ore.

Below are given some average unrevised book costs, which in several cases include transfer costs:

Open hearth billets	$20.87
Universal plates	21.82
Structural shapes	26.52
Merchant bars	28.12
Wire rods	27.21
Black sheets	39.37
Tin and terne plate	71.23

NEWS ITEMS.

The Steel Company of Canada has let the contract for plant extension at Hamilton to the Hamilton Bridge Co.

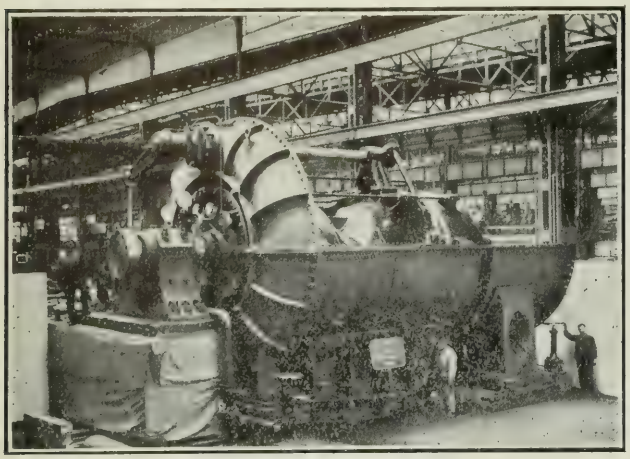
Marsh and Henthorne purpose erecting a new foundry at Belleville, Ont.

NEW ELECTRIC PUMPS.

One or two of the five hundred horse-power electric motors for Toronto's high level pumping station have been in operation for a few hours each day during the past week.

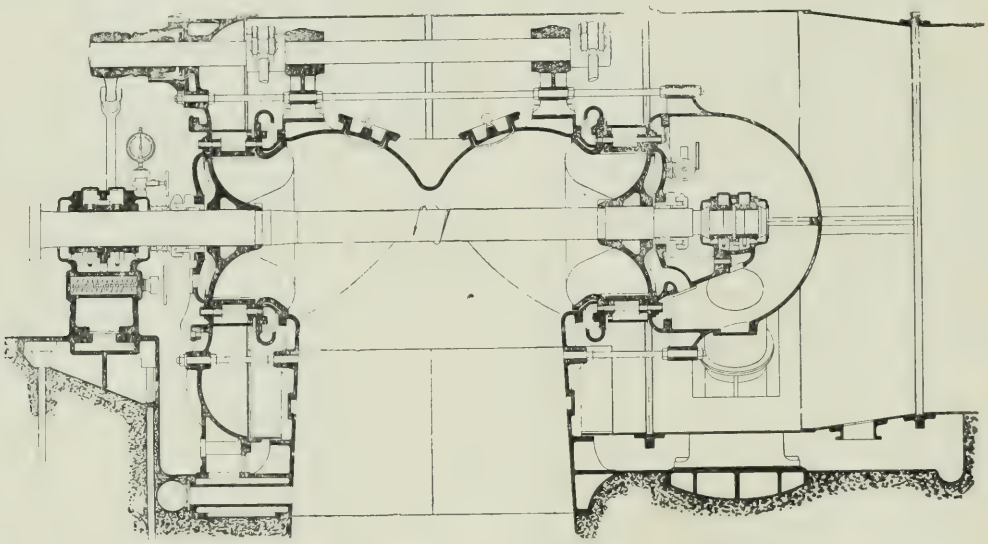
INSTALLATION OF HYDRO-ELECTRIC UNIT.

The first large unit installed by the Western Canada Power Company, Stave Falls, B.C., was started on the 16th of December, last. This unit, which is the largest in Can-



Turbine During Erection.

ada, excepting those at Niagara Falls, was put into service without the slightest trouble developing. After the valve was opened no adjustment was found necessary and the turbine was not again shut down. The present installation comprises two units of 13,000 h.p. each, working under a head of about 110 ft. The hydraulic equipment is supplied by Messrs. Escher, Wyss & Co., of Zurich, Switzerland, Canadian office 408 Lumsden Bldg.. Toronto, and the electrical equipment by the Canadian General Electric Company, of Canada. The accompanying photograph shows the assembling of one of the hydraulic units.



Section Through Turbine.

DEPUTATION FOR GOOD ROADS.

A representative deputation waited upon the Federal Government to urge a comprehensive system of main highways and appropriations for county road construction.

They represented the Good Roads Association of Ontario, the Quebec-Miami International Highway Association, the Toronto and other boards of trade, Ontario Motor League and many municipal and other bodies. The delegation numbered four hundred.

The deputation was introduced by Richard Blain, M.P. for Peel, who laid stress upon the claim that Mr. Borden was the first public man to make good roads a part of his policy. There were two classes who used the roads—the automobilists, who used the middle of the roads, and the farmers and their wives, who were compelled to use the sides of the roads.

Major T. L. Kennedy, president of the Ontario Good Roads Association, pointed out that Ontario possessed 50,000 miles of road, and that there was now no chance of keeping up these roads with the present methods of finance. The Ontario Government had voted a million dollars, but this had all been expended, and if good roads were to be secured Federal assistance was absolutely necessary.

C. J. Foy, of Lanark, emphasized the necessity for Federal aid in the construction and maintenance of good roads. His county (Lanark) had expended $75,000 on 130 miles of road, but it had now come to a point where it could not proceed any further without Federal aid.

Mr. Rankin, M.P.P. for Frontenac, suggested that the Federal Government should pay fifty per cent. of the cost of construction of highways as well as fifty per cent. of the cost of maintenance. There should be township, county, and State highways, and the Federal Government might justly be asked to aid the latter roads.

In reply Rt. Hon. R. L. Borden expressed his pleasure in meeting the delegation and receiving its suggestions. Establishment of good roads, he said, was primarily a matter of provincial jurisdiction. Therefore, it was obvious that the government had a genuine interest in the subject in proposing, as it did, to make grants for the purpose. The condition of roads in Canada was not what should be expected. The civilization of a people was often indicated in its highways.

For Construction.—The premier announced that the supplementary estimates would provide grants to the various provinces for the purpose, but he intimated plainly that the money would be for construction and not for maintenance. In doing the former the government would exceed the B.N.A. Act though doing nothing more than its duty. Details of method of outlay had not yet been determined, but it would be by co-operation with the provinces.

Engineers L. M. Talbot, of Middlesex; H. J. Bowman, Berlin, and E. A. James, of York, were the three engineers accompanying the delegation.

THE CANADIAN FORESTRY ASSOCIATION.

The thirteenth annual convention of the above association has been successfully concluded at Ottawa. The elections resulted in Mr. John Hendry, of Vancouver, being elected president.

Several measures tending toward an increased lumber output were recommended to the Federal Government, among them being the necessity for providing a system of examinations to test the qualifications of appointees and of making appointments permanent during good behavior, and that Federal Government appointments for this purpose should be placed in the hands of the Civil Service Commission. Also, in view of the fact that the expenditure on forest management in Canada is less than one cent per acre of the forest lands, while the average in other countries ranged from two to three cents per acre to $1.90 per acre, that the Federal Government and the Governments of the Provinces should provide large appropriations to assure efficiency of management and increasing profit from the forests of Canada.

It was resolved to impress upon the Government the necessity of maintaining in connection with the forestry branch an experimental laboratory for testing and investigating the physical and mechanical properties of Canadian woods, with a view to extending the possibilities of their use and for other purposes.

The association deprecated the practice of exporting in large quantities of Christmas trees of spruce and balsam, and recommended legislation to prevent that practice.

An executive committee to meet every three months was appointed as follows:—The president, the vice-president, Hon. Sidney Fisher and Messrs. Gordon C. Edwards, R. H. Campbell, G. Y. Chown and Dr. B. E. Fernow.

The committee on forest fire laws reported at very considerable length. This committee is composed of Dr. B. E. Fernow, Dean of the faculty of forestry of the University of Toronto, chairman, and Messrs. Thomas Southworth, ex-Superintendent of Forestry and Colonization for Ontario; W. C. J. Hall, Chief of the Forest Protective Service of Quebec; Ellwood Wilson, forester of the Laurentide Paper Company, Quebec; Dr. Judson F. Clark, forest engineer, British Columbia; Frank Davison, lumberman and member of the Commission of Conservation, Nova Scotia, and G. C. Piche, F. E., chief of the Forest Service, Quebec.

They reviewed the laws of all the provinces, and taking all things into consideration they state that the law of Nova Scotia is probably the most efficient for the conditions there. New Brunswick, Quebec and Ontario have laws which are good in many respects, but they were all primarily designed to protect unorganized territory, and they need to be supplemented by provisions looking to the co-operation of county and township authorities in the organized districts with the officers of the province and the rangers of the lumbermen in the unorganized districts. The laws of the prairie provinces were designed in the first place to stop prairie fires and need to be very considerably supplemented. In British Columbia and the Dominion generally, fire protection is largely a matter of executive administration.

The three main causes of forest fires are railroads, settlers, and persons like sportsmen and prospectors passing through the forests. Regarding railroads, safety there should be sought in improved equipment of locomotives, clearing of the right of way and patrol. In regard to settlers the first suggestion is an educative campaign. Times should be fixed in which settlers must burn the slash from their clearing operations and in each case a permit to burn the same should be secured from the fire warden of the district. Regarding those whose business takes them into the woods, it is suggested that persons like tourists and prospectors passing through the woods should not be allowed to start fires for any purpose without having a permit from the proper officer. Such permits should be for a short time only and renewable upon good conduct. To reduce the danger from lumbering operations the report recommends the burning of slash while the logging operations are going on, or the "downing" of tops and branches so that they may lie close to the ground and rapidly decay.

ENGINEERING NEWS.

Victoria, B.C.—It is anticipated that information relative to the report on the proposed improvements to the outer harbor of Victoria, prepared by Mr. Louis Coste, will shortly be forthcoming.

Victoria, B.C.—That the municipal council select a consulting engineer to confer with the city engineer relative to the necessary work of repair of Smith's Hill reservoir was the suggestion made by Mayor Beckwith.

PERSONAL.

Mr. Willis Chipman, the newly-elected president of the Engineers' Club, of Toronto, is a member of the firm of Chipman and Power, engineers, of Toronto. Mr. Chipman was elected to this position at the annual meeting of this club on February 1st last. Other members elected to office were: 1st vice-president, Mr. T. S. Young; 2nd vice-president, Mr. J. J. Ashworth. 3rd vice-president, Mr. C. H. Heys, Directors: Messrs. Edmund Burke, R. A. Baldwin, W. A. Bucke, E. L. Cousins, W. E. Douglas, H. E. T. Haultain, E. A. James, Jas. McEvoy, A. L. McAllister, G. G. Powell and A. J. Von Nostrand. Secretary-treasurer, Mr. R. B. Wolsey.

Mr. Willis Chipman.

Mr. Ross Thompson has accepted the position of chief engineer of the St. John and Quebec Railway.

Mr. S. B. Wass has been appointed assistant chief engineer of the St. John and Quebec Railway.

Mr. C. W. Powers has been appointed civic engineer of railways, bridges and docks for the city of Toronto.

Mr. Henry Harvie has been appointed chief engineer of the Lake Superior Power Co., Sault Ste. Marie, Ont.

Mr. H. B. Silcox, head of the supply department of the city of Toronto, intends to resign from that position shortly. He will go into business on his own account.

Mr. A. J. Latornel, city engineer of Edmonton, Alta., has reconsidered his resignation notice forwarded to the city officials. He will remain in that position.

Mr. J. D. Whitmore, who has officiated as acting engineer for Moose Jaw since the resignation of Mr. J. M. Wilson some three months ago, has severed his connection with that city. He will return to Regina.

R. O. Wynne-Roberts, M. Inst. C.E., has been appointed by Regina as consulting engineer in connection with that city's additional water supply. Mr. Roberts has also been appointed consulting engineer to report on water supply at Watrous, Sask.

COMING MEETINGS.

THE CLEVELAND ENGINEERING SOCIETY. Special Meeting February 27, 1912, Chamber of Commerce Building, Cleveland, O. "Technical Education (Illustrated)," by Prof. J. F. Barker, Technical High School, Cleveland. Secretary, F. W. Ballard.

THE ENGINEERS' CLUB OF TORONTO, 90-96 King St. West.—Thursday, Feb. 15th. Dinner at 6-30; Lecture at 8 p.m., in Dining Room. After dinner address by Prof. W. R. Lang, Major Canadian Engineers, "Organization, Administration, Duties and Achievements of the Engineering Forces of the Crown," illustrated with models and lantern slides of Bridges constructed by the Royal Engineers in different parts of the Empire. R. B. Wolsey, Secretary.

CANADIAN NATIONAL ASSOCIATION OF BUILDERS.—The Sixth Annual Convention will be held in Toronto, February 20, 1912.

ONTARIO GOOD ROADS ASSOCIATION.—Annual Convention to be held at Toronto, February 26, 27, 28. Secretary, J. E. Farewell, Whitby.

THE ENGINEERS' CLUB OF TORONTO, 90-96 King St. West.—Thursday, Feb. 29th, 8 p.m. Meeting of Toronto Branch of Canadian Society of Civil Engineers. R. B. Wolsey, Secretary.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—**President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.**

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready **City Clerk, Fredericton.**

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—**President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.**

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—**President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.**

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—**President, N. McMurchy; Secretary, Mr. McClung, Regina.**

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—**President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.**

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary, H Mortimer-Lamb, **Windsor Hotel, Montreal.**

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

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CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, **409 Union Station. Meets third Tuesday each month except June, July, August.**

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

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INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary, R. C. Harris, City Hall, Toronto.

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NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

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WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

TENDERS PENDING

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Calgary, Alta., concrete substructures, etc.	Feb. 18.	Feb. 8.	59
Calgary, Alta., electric machinery	Mar 15.	Feb. 8.	68
Calgary, Alta., sluice gates	Feb. 29.	Feb. 1.	68
Galt, Ont., Y.M.C.A. building	Feb. 24.	Feb. 1.	59
Edmonds, B.C., steel pipes	Mar. 11.	Feb. 8.	68
Esquimalt, B.C., schooner	Feb. 15.	Feb. 8.	59
Little Lameque, N.B., wharf	Feb. 14.	Jan. 25.	59
Kerrisdale, B.C., valves, hydrants, etc.	Feb. 19.	Feb. 1.	59
Keremos, B.C., quarantine station	Mar 1.	Feb. 8.	59
Lake Quinze, Que., dams and sluiceways	Feb. 15.	Jan. 25.	59
Lethbridge, Alta., extension to power house	Feb. 15.	Feb. 1.	59
London, Ont., engines and pumps	Feb. 14.	Feb. 1.	70
Lockport, Man., Red River bridge work	Feb. 20.	Feb. 8.	59
Meaford, Ont., construction work on E. Breakwater; dredging	Feb. 26.	Feb. 1.	59
Moose Jaw, Sask., elevator water tank	Feb. 26.	Feb. 8.	68
Ottawa, Ont., civic supplies	Feb. 13.	Feb. 8.	68
Ottawa, Ont., waterworks supplies	Feb. 13.	Feb. 8.	70
Ottawa, Ont., launches	Feb. 24.	Feb. 1.	59
Ottawa, Ont., contracting machinery	Feb. 26.	Jan. 11.	59
Ottawa, Ont., outlet pipe	Feb. 15.	Feb. 8.	70
Saskatoon, Sask., subway	Feb. 23.	Jan. 25.	68
Saskatoon, Sask., pavements	Feb. 16.	Jan. 18.	86
Saskatoon, Sask., concrete sidewalks	Feb. 16.	Jan. 18.	86
Swift Current, Sask., theatre	Feb. 16.	Jan. 25.	59
Toronto, Ont., track intersections, etc.	Feb. 20.	Jan. 25.	72
Toronto, Ont., bridges	Mar. 2.	Feb. 1.	59
Toronto, Ont., sewer, Toronto Junction	Feb. 27.	Feb. 8.	68
Toronto, Ont., macadam highway road	Feb. 15.	Feb. 8.	68
Upper Salmon River, N.B., pier.	Feb. 14.	Jan. 25.	59
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., pumping machinery	Mar. 1.	Jan. 25.	72
Winnipeg, Man., piers and abutments, Red River bridge	Feb. 14.	Feb. 1.	59

TENDERS.

Calgary, Alta.—Plans for the proposed theatre on Eighth avenue, and an application for a permit for the building have been filed at the office of the city building inspector. The cost of the structure is estimated at $30,000.

Calgary, Alta.—Ex.-Ald. J. S. Mackie is contemplating the erection of a $250,000 business block, corner of 8th Ave. and Second Street West.

Calgary, Alta.—Tenders for electric machinery consisting of: One 2,500 K.W. turbo generator; one 1,000 K.W. synchronous motor generator; one 50 K.W. motor driven exciter; one 25 K.W. motor driven exciter. All delivered and erected in Calgary, will be received until March 15th, 1912. J. M. Miller, City Clerk.

Edmonton, Alta.—The school board contemplate calling for tenders for the erection of a $112,000 school building.

Hamilton, Ont.—Tenders will be received until February 28th, 1912, for the supply and delivery of 2,200 lineal feet of 48-inch steel intake pipe with expansion joints, intake and flanged specials, sluice valves, bolts and gaskets. S. H. Kent, City Clerk, City Hall. (See advt. elsewhere in the Can. Eng.)

Hamilton, Ont.—Tenders will be received by the chairman of the Board of Control, City Hall, until February 19th, 1912, for supplying the corporation of the city of Hamilton with the following supplies: Lime, jute packing and reinforced concrete pipe. Specifications at the office of the City Engineer of Hamilton, where forms of tender can be obtained. S. H. Kent, City Clerk.

Hamilton, Ont.—Tenders will be received until February 28th, 1912, for the supply and delivery of 2,200 lineal feet of 48-inch steel intake pipe with expansion joints, intake and flanged specials, sluice valves, bolts and gaskets. Plans and specifications can be obtained from A. F. Macallum, City Engineer, City Hall, Hamilton. S. H. Kent, City Clerk. (See advt. elsewhere in Can. Eng.)

New Westminster, B.C.—Tenders for the erection and completion of two concrete dams, excavation of river channel, in the Nicomeki and Serpentine Rivers in the Municipality of Surrey, New Westminster district, will be received until noon, March 10th, 1912. Drawings, specifications, etc., may be obtained at office of Harvey C. Brice, C.E., Room 3, Westminster Trust Block, New Westminster, B.C.

Ottawa, Ont.—Tenders for structural modifications to Fishery Protection Vessel "Canada," will be received until noon, February 15th, 1912, by G. J. Desbarats, Deputy Minister of Naval Service, Dept. of Naval Service, Ottawa. Full particulars obtained on application to Commander in Charge, H.M.C. Dockyard, Halifax, N.S.

Ottawa, Ont.—Tenders will be received until February 19th, 1912, for interior fittings, Post Office and Customs, Grand Falls, N.B. Plans, etc., at office of Mr. F. L. Dixon, Clerk of Works, Grand Falls; Mr. D. H. Waterbury, St. John, Clerk of Works, and Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders are invited for the construction of a Quarantine Station at White Rock, B.C., to be received until March 15th, 1912; specifications, etc., obtained from S. Ranson, V.S., Post Office Building, Vancouver, or S. F. Tolmie, V.S., Victoria, B.C. A. L. Jarvis, Asst. Dep. Min. and Secr. of Agriculture, Ottawa.

Ottawa, Ont.—Tenders will be received unil February 28, 1912, for the reconstruction of approach to the Government Wharf at Sault Ste. Marie, Ont., plans, etc., of which can be seen at the offices of J. G. Sing, Esq., district engineer, Confederation Life Building, Toronto. H. J. Lamb, Esq., district engineer, Windsor, Ont., on application to the Postmaster at Sault Ste. Marie, and the offices of R. C. Desrochers, Secr. Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until noon, February 22nd, 1912, for the installation of new fittings in the Drill Hall at Windsor, Ont. Specinfications, etc., at the offices of the Officer Commanding the 21st Regiment, Windsor; the Officer Commanding 1st Division, London, Ont.; and the Director of Engineer Services, Headquarters, Ottawa. Eugene Fiset, Deputy-Minister, Department of Militia and Defence, Ottawa.

Saskatoon, Sask.—Tenders will be received by the City Commissioners until February 22nd, 1912, for furnishing meters, transformers, wire, globes, and other electrical sup-

plies required by the city during the year 1912. (See advt. elsewhere in Can. Eng.)

Saskatoon, Sask.—Tenders will be received by the City Commissioners until March 8th, 1912, for electrical equipment. (See advt. elsewhere in Can. Eng.)

Saskatoon, Sask.—Tenders will be received by the City Commissioners until March 1st, 1912, for furnishing sewer pipe and junctions, cast-iron pipe and specials, etc. (See advt. elsewhere in Can. Eng. for full details.)

Swan River, Man.—Tenders will be received until February 29, 1912, for the erection and completion of a six-room brick school, for all trades except excavating, concrete and plumbing. Drawing and specifications may be seen at the offices of C. A. Lewis, secretary-treasurer, Swan River, Man.; T. C. Silverthorne, superintendent, Bowsman River, Man., and E. D. Tuttle, architect, 701 McArthur Building, Winnipeg.

Toronto, Ont.—It was decided at a meeting of the Harbor Board to ask at once for tenders for the rental of the city docks, which were recently turned oved to the board by the city. Mr. E. L. Cousins, Engineer to the Board.

Toronto, Ont.—The chairman of the board of control will receive tenders until March 7th, 1912, for the grading and construction of the concrete abutments and wing walls for Coxwell Avenue Subway. G. R. Geary (Mayor), chairman, Board of Control, City Hall, Toronto. (See advertisement in Canadian Engineer).

Toronto, Ont.—Tenders will be received by the board of control up to noon, February 27th, 1912, for the annual supply of asphalt for the year ending December 31st, 1912. G. R. Geary (Mayor), chairman, Board of Control, City Hall, Toronto. (See advertisement in Canadian Engineer.)

Toronto, Ont.—Wm. Panton, County Clerk, Milton, Ont., will receive tenders up to noon, March 4th, 1912, for completing the construction of a reinforced concrete arch of 135 foot span and 340 feet of concrete viaduct approach on the Middle Road between the town of Oakville and the Township of Trafalgar. Frank Barber, Consulting Engineer, Toronto. (See Advertisement in The Canadian Engineer.)

Victoria, B.C.—Tenders will be received until February 16th, 1912, for furnishing and fitting in place steel shelving, etc., required for the vaults of the government offices at New Westminster. Plans, etc., at the offices of the government agent, New Westminster; the Provincial Timber Inspector, Court House, Vancouver; and J. E. Griffith, Public Works Engineer, Dept. of Public Works, Victoria.

Winnipeg, Man.—Tenders will be received until February 20th, 1912, for the supply and delivery f.o.b. Winnipeg, of the following crushing plant: One No. 3 gyratory crusher without back gear driving attachment; to be fitted with chilled iron head and concaves. One No. 5 stone elevator complete with buckets, length 60-ft. One No. 5 revolving screen complete, length 16-ft., in 3 sections, and dust jacket screen. Sections to be made of ¼-in. plate and perforated as follows: 1st section, ¾-in.; 2nd section, 1¼-in.; 3rd section, 2-in.; dust jacket, ⅜-in. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received until March 1st, 1912, for the supply and delivery f.o.b. Winnipeg, of the following equipment: 1 44-ton or 45-ton steam shovel equipped with a dipper of at least 1¼-yard capacity, with a clear lift from rail to bottom of dipper door, when open, of not less than 16 feet; 1 locomotive of regular standard gauge to have a hauling capacity of at least 350 tons on a 1 per cent. grade and equipped both front and back with attachment for coupling to standard 80,000-lb. railway cars. Full specifications and drawings must accompany each proposal. M. Peterson, Secretary Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received by the Chairman, Board of Control, until February 13th, 1912, for the supply and delivery f.o.b. Winnipeg, of one only 24-inch disk rock crusher complete. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received by the chairman, board of control, until March 25th, 1912, for the manufacture and delivery f.o.b. Winnipeg, of impregnated paper lead covered cables, to be used in connection with the city's fire and police telegraph system. Full particulars at the office of the city electrician, City Hall, Winnipeg. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received until February 22nd, 1912, for supply of three 50-k.w. transformers, motor, and accessories for installation at Well No. 4. Specifications, etc., at office of city engineer, 223 James Avenue. Mr. Petersen, secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received by the chairman, board of control, until March 1st, 1912, for the supply and delivery f.o.b. Winnipeg, of a quantity of C. L. water pipe, gate valves, and hydrants for extension of the domestic waterworks system. Specifications and forms of tender may be obtained at the office of the city engineer, 223 James Avenue. Mr. Petersen, secretary, Board of Control Office, Winnipeg.

Victoria, B.C.—Mr. W. Ridgway Wilson, architect, will receive tenders until March 5, 1912, for the construction of St. John's new church edifice. Material used to be brick and terra cotta.

CONTRACTS AWARDED.

New Westminster, B.C.—Messrs. J. Coughlan & Sons have received the contract of raising the high tension wires of the British Columbia Electric Railway Company on the Government bridge across the Fraser River. Contract will involve an expenditure of about $10,000.

St. John, N.B.—The contract for the development of the Grand Trunk Pacific Terminals in Courtenay Bay, St. John, has been awarded by the Government to Norton Griffiths, the English contractor. The contract involves an expenditure of $7,500,000.

Winnipeg, Man.—Messrs. McMillan Bros., railroad contractors, have secured from J. D. McArthur a sub-contract for 185 miles of the Hudson Bay Railway, commencing at Le Pas and extending eastward to a point west of Split Lake.

Vancouver, B.C.—Tenders dealing with the Waterworks Committee in regard to supplies for the Seymour Creek work, have been awarded as follows: The lead piping tender was awarded to Messrs. Robertson, Godson & Company for $3,920. That for the galvanized iron pipe was given to Messrs. Crane & Company at the price of $3,472.50. The contract for the pig lead was secured by Messrs. Evans, Coleman & Evans at $94.08 a ton. The successful tender for the brass goods was that of Messrs. Simson, Balkwill & Company at the sum of $1,054.

Victoria, B.C.—Mr. Harrison, Victoria, has a contract for the erection of a modern two-story factory on Garbally road. Latest kind of electrical machinery to be installed. Owners, Messrs. Hallwards, Limited, furniture manufacturers. W. D. H. Rockfort, architect.

Victoria, B.C.—The contract for the erection of a one-story brick structure for a manual training centre at the North Ward school, was awarded to Messrs. Luney Bros., at a cost of $3,230.

RAILWAYS—STEAM AND ELECTRIC.

The Board of Railway Commissioners for Canada will hold a sittings at the Court Houses at Calgary, Alta., Thursday, March 14th, 1912; Edmonton, Alta., Monday, March 18th 1912; Regina, Sask., Friday, March 22nd, 1912, and at the City Hall, Winnipeg, Man., Monday, March 25th, 1912. At these sittings the board will consider the matter of freight rates in western Canada.

Calgary, Alta.—Surveyors are at work preparing the route for the Calgary Street Railway's extension to the Canadian Pacific Railway Company's shops site, east of the Bow River, and work will be started in the near future.

Fredericton, N.B.—A very attractive station for the I.C.R. is almost completed at this point. Messrs. M. Ryan & Son are the contractors. Considerable concrete paving will be necessary in the spring.

Galt, Ont.—The franchise of the Galt, Preston and Hespeler Railway has been renewed for ten years.

Kingston, Ont.—A contract for 25 locomotives has been placed by the Grand Trunk Pacific Railway with the Canadian Locomotive Company, Kingston, Ont., for delivery May, 1912. These are of simple consolidation type, with Schmidt superheaters, having cylinders 25 inches in diameter by 30 inches stroke, 63-inch driving wheels, and a boiler pressure of 180 pounds.

Moose Jaw, Sask.—The Canadian Northern Railway have closed an agreement with the city council for the entrance into the city, and for the station site. The new station will be at the east end of the city, facing and immediately east of the Crescent Park and baseball ground.

For medium traffic and residential streets.

$ Dolarway Pavement

For permanent state highways, park roads, boulevards, etc.

IT IS PERMANENT BECAUSE IT IS CONCRETE.

What is Dolarway Pavement?

FIVE to six inches of Portland Cement Concrete provided with the necessary expansion joints. The surface is then treated with our adhesive Dolarway Bitumen and with coarse sand or fine gravel or screenings. This seals the concrete, prevents cracking and chipping, and produces a wearing surface which is clean, noiseless, resilient and similar in appearance to other forms of bituminous pavement.

It does not bleed in hot weather, neither does it become brittle or peal in the cold. It is a well-known fact that moisture causes concrete to expand and contract 5 times as much as a change in temperature. Our seal coat keeps out this moisture, thereby preventing the cracking and chipping which would otherwise occur.

What Does It Cost?

You can figure out what the concrete will cost per square yard in your vicinity. Add to this from 25 cents to 35 cents per square yard which represents the cost of the bitumen, sand and labor, and the small royalty charged by our Company.

Great Economy Possible.

Sealing the surface of the concrete by our method makes it possible, for the first time, to construct a pavement or highway having a concrete base and a noiseless bituminated wearing surface at from 50 cents to $1.00 per square yard less than the cost of any other permanent pavement.

Low Cost of Maintenance

The Dolarway Pavement can be resurfaced when necessary at a price of from ten to twenty cents per square yard, thus making it as good as new and prolonging its life indefinitely.

Medium Traffic and Residential Streets.

Permanent, noiseless and dustless. Not affected by motor traffic. Ideal for the smaller cities, as no expensive machinery is required.

For Good Roads.

Wherever there is gravel or stone (hard or soft), you can build Dolarway Pavement cheaper than any other permanent roadway.

Dolarway Succeeds Macadam.

State, County and City officials now prefer to lay Dolarway rather than macadam. This is due to the fact that Dolarway costs only a few cents more per square yard and the cost of maintenance is reduced to a minimum.

Notice to Contractors.

Correspondence solicited from contractors to represent Dolarway Pavement for unallotted territory. Write or call at once for pamphlets and circular telling what Engineers, Contractors and others think of Dolarway.

DOLARWAY PAVING COMPANY

95 Liberty Street,
NEW YORK CITY.

510 Title and Trust Building,
CHICAGO.

One of the methods of applying and spreading Dolarway Bitumen on Concrete Base.

Finished Dolarway Pavement.

North Bay, Ont.—Town Solicitor McNamara is taking necessary steps to apply for a street car charter for the town, to connect with Callander, Trout Mills and Sturgeon Falls.

Northern Ontario.—J. L. Englehart, chairman of the Commission, T. & N. O. Railway, stated that tenders for the construction of the Elk Lake line would be called in the spring.

Ottawa, Ont.—The matter of requiring all electric railway companies in Canada to equip their cars with automatic fenders will be discussed by the Railway Board on March 5 next.

West Toronto, Ont.—It is the intention of the Grand Trunk Railway to double-track its main line from West Toronto to Weston, Ont.

Winnipeg, Man.—The Canadian Northern Railway contemplate building new yards at this point.

Victoria, B.C.—The Canadian Mineral Rubber Company have a large crew at work laying concrete between the double tracks on Burnside road for the Saanich extension of the B. C. Electric Railway Company.

LIGHT, HEAT AND POWER.

Calgary, Alta.—W. R. Martin, of Medicine Hat, one of the promoters of the Canada Western Gas, Heat, Light and Power Company, is reported to have stated that the construction of the pipe line from Bow Island to Calgary will be commenced from the east at an early date.

Calgary, Alta.—Another flow of natural gas has been struck at Bow Island, which will be piped across 181 miles of country to this city.

Duncan, B.C.—A company to supply Duncan with electric light and power is being formed. The promoters expect to have the town lighted by electricity before next autumn.

Guelph, Ont.—A report states that the power consumption in Guelph for January last amounted to $2,300.

Halifax, N.S.—The street railway receipts for the week ending February 7th, 1912, were $3,979.44, an increase of $66.16 over the same period last year.

London, Ont.—Mr. C. B. King, manager of the London Street Railway Company, has been instructed by the directors to secure tenders on a new steam power plant.

Nelson, B.C.—The flat rate system of supplying electric light to citizens was severely criticized by H. P. Thomas, the new superintendent of the city's power and light system. He recommended to the council that the flat rate system be abolished and meters installed in all houses.

Orillia, Ont.—The town of Orillia during this session of the legislature will seek authority to issue debentures for $80,000 to construct a connecting pole line to the Simcoe Power Company's plant at the Big Chute on the Severn River.

Ottawa, Ont.—Hon. Adam Beck is reported to have stated that the provincial government will develop power at Chats Falls on the Ottawa River.

Prince Albert, Sask.—The committee in charge of the municipal power plant recommended that a supply of motors be purchased for renting purposes. F. A. Creighton, City Engineer.

Province of Saskatchewan.—A bill is at present before the provincial government to develop the deposits of lignite, known to exist throughout the province, for power purposes.

Saskatoon, Sask.—The superintendent of the civic power plant, Mr. H. G. Sangster, has been notified that the council approve of the calling of tenders for the following plant: Five hundred housepower water tube boilers with automatic stokers, economizers and independent draught appurtenances; a 2,000 k.w. high pressure steam turbine with generator, condensers, air pump, exciters, and all the necessary equipment for a complete plant. The machinery, which will be placed in the power house will cost $175,000. It will be ten months or a year before the installation is completed.

Winnipeg, Man.—Work on the underground distribution system is to be resumed at once so that the underground district connections may be ready as soon as possible after current is available from the King Street sub-station.

Verdun, P.Q.—The municipal council are considering plans for the extension of the electric light system. Mr. H. Hadley, jr., engineer.

GARBAGE, SEWAGE AND WATER.

Niagara Falls, Ont.—The waterworks board are about to consider certain plans being prepared to improve the intake and waterworks plant. One of the ideas is to introduce a tube below the flow of water at the intake to increase the volume. Other radical changes in the wheelpit and the underground flume will be suggested in the plans which are expected from Mr. Kennedy, Montreal, in a short time. Mr. R. P. Slater, water commissioner, is interested in this work.

Port Stanley, Ont.—This municipality will vote on a waterworks by-law in the near future. Mr. Bell, city engineer of St. Thomas, Ont., is interested in the matter. There are twenty fire hydrants and a large standpipe in the plans now prepared.

Regina, Sask.—Mr. R. O. Wynne-Roberts, who has prepared a report on the new water supply of this city, states that the construction of the first section will entail 6 miles of earthenware pipe from 6 to 18-inches diameter, 5 million gallon reservoir, 3 million gallon water softening plant, meters, etc. The second section will consist of 8 miles of 27-inch steel mains, 8 miles of earthenware pipe from 8 to 40-inches, pumping plant, water softening plant, buildings and small reservoir.

Toronto, Ont. — A report, with estimated costs, on a scheme to supply Toronto with water from Scarboro Heights will be presented to the council at an early date. Mr. I. Randolph, Chicago, is chairman of the board preparing the report.

Verdun, P.Q.—The municipal council are considering plans for the extension of the municipal water system and the filtration plant. Mr. H. Hadley, jr., engineer.

Victoria, B.C.—Mr. William W. Northcote, municipal purchasing agent, is contemplating the purchase of one or more motor trucks to be used in the collecting of house garbage. He is also making inquiries relative to the purchase of twelve garbage waggons.

BUILDINGS AND INDUSTRIAL WORKS.

Edmonton, Alta.—Messrs. Revillon Bros., Ltd., of this city, will erect a six-story warehouse on the Fourth Street spur; the building to be 150 by 150 feet.

Galt, Ont.—The community is seeking authority to overcome certain legal difficulties in connection with the eerction of a municipal abattoir. Mr. McArthur is secretary to the board of health.

Fort William, Ont.—A report states that the Grand Trunk Pacific Railway will erect a thirty million bushel grain elevator at Fort William.

Galt, Ont.—Messrs. Goldie & McCulloch will spend $80,000 on improvements to their buildings and machinery. The Y.M.C.A. will erect a $70,000 structure.

Montreal, P.Q.—A report states that the Dominion Steel Corporation will erect a large warehouse and make Montreal a distributing point for their manufactured goods, such as nails, rods, and all the wire goods which are soon to be turned out by the plant that is now being constructed at Sydney, C.B., Nova Scotia, for this purpose.

Montreal, P.Q.—Mr. Arthur Beauchesne is taking charge of the publicity work in connection with the erection of a monument to Cartier. The cost of the monument will be $10,000.

Moose Jaw, Sask.—An agreement has been reached whereby the Robin Hood Mills of the Saskatchewan Flour Mills Company, will be rebuilt at Moose Jaw. According to agreement the mill must be of concrete construction and the buildings will include a 3,000-barrel flour mill and a quarter million bushel elevator. A 600-barrel oatmeal mill is also on the programme.

Moose Jaw, Sask.—The Rumley Company, manufacturers of threshing machinery, have decided to locate in Moose Jaw. Mr. William Crosbie has been appointed manager of the Moose Jaw branch.

Nanaimo, B.C.—This municipality contemplates spending $50,000 on new school buildings during 1912.

Niagara River, Ont.—The Sanitary Packing Company will erect a large dock half way between Queenston and Niagara-on-the-Lake. The head office of this company is in Toronto, Ont.

The "ENGBERG" VALVE

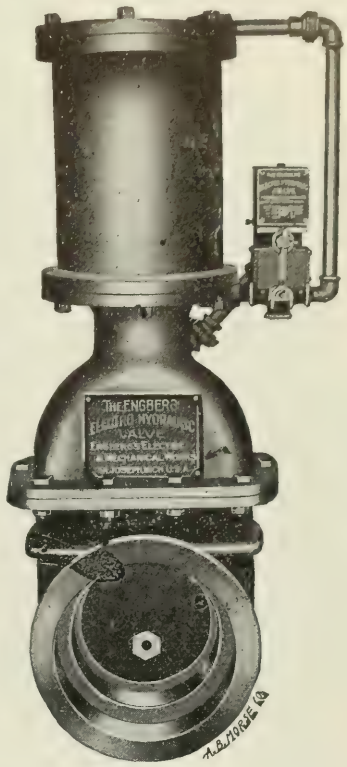
A VALUABLE ADJUNCT

No waterworks system, having a standpipe or reservoir, can afford to be without this valve, a most valuable adjunct, increasing the effectiveness when fire pressure is desired and permitting a reduction in the cost of maintaining ordinary domestic pressure.

We are sole agents for Canada.

Read what a Fire Chief says—

"Your electric shut-off valve has been a great assistance to us in putting out fires, as it enables the engineer at the pumping station to increase the water pressure in an instant, whereas it took from twenty to thirty minutes to change before the same was put in; a man having to go to the stand pipe and close the valve and also telephone to the engineer notifying him of the same. Now it is all done at the pumping station, and by the time we are able to make connections we have direct pressure. Any chief knows what it means to try and fight fire without sufficient water pressure."



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Full Particulars and Estimates Furnished.

Orillia, Ont.—The sum of $60,000 has been placed in the supplementary estimates for the building of an armory, and it is probable that the early summer will see the work of erection well under way.

Ottawa, Ont.—Mr. G. F. Hodgins, of Shawville, P.Q., is president of a new shale brick industry, building operations on which have been started at Russell. It will employ about 100 men and will have a capacity of 100 tons per day.

Ottawa, Ont.—Ald. Lapointe secured the approval of the city council for an initial expenditure of $20,000 on public lavatories this year. A committee will be formed.

Ottawa, Ont.—The civic building programme for 1912 includes the erection of a $45,000 smallpox hospital, $12,500 tubercular hospital, $30,000 fire station and equipment, $20,000 public lavatories. The estimates also include an item of $10,000 for an incinerator site. John Henderson, town clerk.

Ottawa, Ont.—A new telephone exchange for the Glebe section of the city, in addition to the second exchange to be opened shortly in Lower Town, is planned for the near future by the Bell Telephone Company.

Point Grey, B.C.—The Board of Education have applied to the municipal council for $114,200, to be used for the erection of three new school buildings. Mr. M. C. Gordon, secretary of the board of school trustees.

Port Arthur, Ont.—The Canadian Northern Railway will erect a $40,000 dock at this point.

Port Mann, B.C.—The International Milling Company, Minnesota, Iowa, U. S. A., contemplate the erection of a 5,000 barrel flour mill at this point. Mr. F. A. Bean, Moose Jaw, is interested.

Saskatoon, Sask.—The St. James' Anglican Church congregation contemplate spending $10,000 on a new church building. Mr. J. Eadon-Reaney is vestry clerk.

St. Catharines, Ont.—The Sterling Bank of Canada and the Traders Bank of Canada contemplate the erection of bank buildings in this city.

St. Thomas, Ont.—Secretary W. H. Tallman of the board of education states that the plans prepared by Architect John T. Findlay for the proposed extension to the collegiate, had been approved. Work is to be commenced as soon as the weather will permit.

Thorold, Ont.—A new paper plant for this town will employ between 150 and 200 men. The plant will be erected on the frontage facing Grand Trunk Railway tracks.

Toronto, Ont.—The I.O.O.F. Hall Association of Toronto, Limited, decided to build a new $100,000 hall on their property at 229 College Street. The new building will be 130 feet long by 65 feet wide and will be fireproof throughout. It will be five stories high, and will have a large auditorium.

Welland, Ont.—The Canadian Steel Foundries are considering the erection of a $150,000 plant in Welland. B. J. McCormick, Welland, has been looking after a suitable site, etc.

Welland, Ont.—Mr. Wellington Downing, of Erie, Pa., is interested in a project to erect a large hotel in this town during the coming year. The cost is estimated at $150,000.

Winnipeg, Man.—The board of control has ordered the completion of plumbing work at the King Street sub-station, at an estimated cost of $900. Mr. Glassco, power manager.

Victoria, B.C.—It is stated that certain improvements to the outer harbor, now pending, will necessitate the British Columbia Soap Co., and the British America Paint Co., building new plants.

Victoria, B.C.—Mr. M. Warren, architect, has completed plans for a new building to be erected for the Canada Mosaic Tile Company. The structure is to cost $25,000. Mr. Warren will call for tenders for its construction shortly.

Vancouver, B.C.—Plans for the extension of the Great Northern Railway Company's docks at this point are being considered. These plans call for an additional 200 feet of concrete work. The head office of this company is in St. Paul, Minn., U.S.A.

Vancouver, B.C.—It is expected that two oil storage tanks will be constructed near the site of the present one at the Western Transfer shed. The tanks to be built will have a capacity of 55,000 barrels. They are to be built for the Canadian Pacific Railway.

Vancouver, B.C.—Mr. Abraham Grossman is interested in a ten-story structure to be erected in this city. It will be of steel and brick, and cost about $500,000.

Verdun, P.Q.—The Federal Government are planning changes on the river front, where an up-to-date wharf and a properly dredged approach is expected to materialize early in the spring, thus enabling the corporation to complete the dyke and boulevard scheme, that is now practically finished, from the southern limits of the town to this point. Mr. H. Hadley, jr., town engineer.

Victoria, B.C.—A large warehouse being built for Messrs. R. P. Rithet & Co., is nearing completion. It is to be covered with galvanized iron.

BRIDGES, ROADS AND PAVEMENTS.

Niagara Falls, Ont.—The chairman of the board of works and the city engineer, Mr. J. C. Gardner, will visit several near-by cities to inspect the pavement, in order that they will be able to render a report as to which kind of road covering is the most suitable.

Ottawa, Ont.—A deputation waited upon Hon. Frank Cochrane to urge a grant toward the construction of a bridge across the Rideau Canal at Pretoria Avenue. The estimated cost of the bridge, on plans prepared by the city engineer, Mr. N. J. Ker, is $133,500. The land and building damages will total $53,450, making a total of $185,950. A report will be made.

Province of Ontario.—The Ontario Government intend spending an additional million dollars on country roads.

Penticton, B.C.—Mr. H. A. Turner, who has been superintending the surveys for new roads to be opened throughout the Okanagan during the coming summer, has plans for a new steel and concrete bridge which will span the Okanagan River on Fairview Road, near Penticton. Construction is to commence in the early spring.

Thorold, Ont.—The Thorold town council decided to do considerable permanent paving in the near future.

Toronto, Ont.—The Board of Control will advertise for tenders for the year's supply of asphalt. Specifications are to be drawn up by the City Engineer, Mr. Rust.

FIRES.

Guelph, Ont.—$1,000 damage was caused by fire to the biological building of the Agricultural College.

Hamilton, Ont.—The printing and stationery establishment of Robert Duncan was damaged by fire to the extent of $200,000. Several nearby buildings were also damaged.

Owen Sound, Ont.—The Owen Sound Wire Fence Company was lately damaged by fire. Damage is estimated at $3,000.

Parry Sound, Ont.—The ratepayers passed the by-law to bonus the iron works. Major Peuchen, of the Standard Chemical Company, Toronto, is interested.

St. Boniface, Winnipeg, Man.—The sash and door factory of the D. McCormick Company, in St. Boniface, was totally destroyed by fire with a loss of $25,000 in buildings and machinery.

CURRENT NEWS.

Edmonton, Alta.—The building permits of Edmonton and Strathcona for January 1912 amounted to $167,600, an increase of 107.5 per cent. over the corresponding period in 1911. Strathcona is a recent addition to the City of Edmonton.

Fort William, Ont.—The municipal Board of Works are considering appointing a purchasing agent for all supplies not purchased by tender. A. McNaughton, city clerk.

Masset, Queen Charlotte Islands, B.C.—Residents of the town are asking the provincial government for an experimental farm, donkey engines for road work, a large appropriation for road construction, and for assistance for the settlers in draining the large areas of semi-swamp lands.

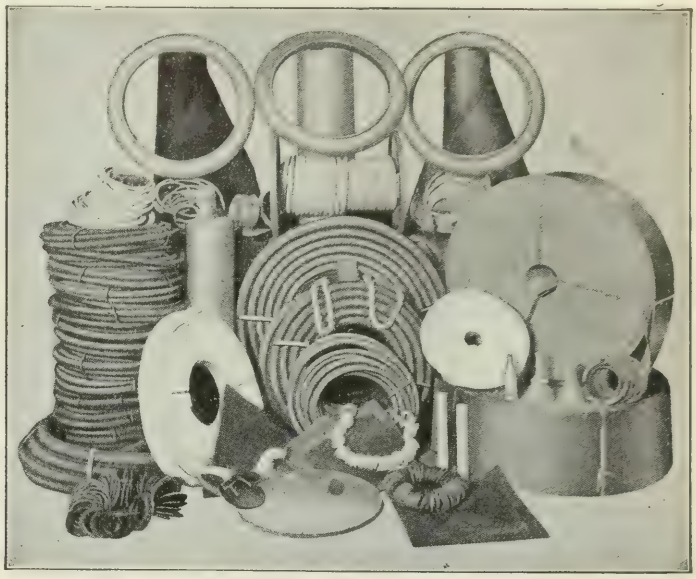
New Liskeard, Ont. — At the Temiskaming Telephone Company annual meeting a report was read which showed that the gross income of the company for 1911 was $32,041.40,

Only Reliable Suction Hose

If you are in the market for **hose,** don't do a thing until you look into the money-saving reasons why you should buy

GOODYEAR Suction Hose

Money-Saving Hose for Contractors, Miners, Dredgers and Others Demanding Hose-Permanency and Hose-Strength.



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Longer service, more *stand-up-ability*, greater freedom from constant repairs, would make Goodyear Suction Hose an economy at double the price. But it *costs no more* than the other kinds.

Non-Collapsible—Non-Rotting

Goodyear Suction Hose never caves in. It is built by a process that makes this impossible no matter how long the hose has been in use. It is built around a heavy steel spiral wire imbedded in the inner tube. Tube can't separate from wire nor can dampness reach it. Hence, rust and rot, one of the common failings of other makes of suction hose, is *done away with*.

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We make rough or smooth bore Suction Hose for all purposes; also a complete line of

Water, Steam and Air Hose

Send at once for our catalog. If you are in doubt as to what kind of hose you need, let our expert help you solve your problem. In all of our business in Canada last year, we had to replace because of slight defects, only $155.22 worth of goods. Write us tonight. (13)

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BRANCHES: Montreal—Winnipeg—St. John, N.B.—Vancouver—Calgary—Victoria, B.C., 855 Fort St. Regina, Sask., 2317-2318 South Railway Street — Hamilton, Ont., 127 King Street West.

which compared with the gross income of $31,042.05 for 1910 shows an increase of $999.35. The net ncome for 1911 was $16,416.09, as compared with $15,933.96 for 1910.

Creston Valley, B.C.—A reclamation survey of 40,000 acres of flats in the Kootenay valley, will be made by the provincial government with a view to reclamation. It is estimated that the reclamation work will cost half a million dollars. The survey will take nearly a year.

St. John, N.B.—Mr. William Murdoch, municipal engineer, will offer for sale at public auction on Saturday, February 17th, 12 o'clock noon, one steam dredge and two hopper scows belonging to the city.

Toronto, Ont.—The cost of dredging the River Don from Winchester Street to its mouth, the city engineer, Mr. Rust, reports, would be $200,000, and to construct retaining walls, with twelve foot sidewalks on each embankment $290,000, a total of $490,000. The river bed is full of weeds and muck, and the piling on each side has broken away in many places.

Winnipeg, Man.—A. N. Stokes, president of the British Institute of Architects, has been appointed assessor to award the prizes in the competition for the new Manitoba Provincial Government building plans.

Victoria, B.C.—Mr. Harry Worswick, superintendent of construction on civic works, is arranging for the better and more expeditious handling of his force in the matter of more detailed daily reports of progress on the various works, cost of same, etc.

COPY OF ENGINEER WANTED.

A copy of our issue of No. 1 of volume 17 is required. (The first issue of January 1907.) The usual extension of one month will be made to the party sending in this paper.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

15844—January 27—Disallowing G.T.R. and C.P.R. tariffs on application Consumers Cordage Co., Ltd., until further order of the Board. Rates on rope.

15845—January 26—Authorizing C.P.R. to construct its Pheasant Hills Branch across thirty-one highways, mileage 202 to 252.92.

15846—January 27—Adding County of Halton party to application of Twps. of Nelson for protection of Plains Road crossing west of Burlington Jct. on G.T.R.

15847—January 25—Authorizing G.T.R. to reconstruct bridge No. 236 over Chateauguay River, mileage 43.82, at Bryson's, Que.

15848—January 25—Amending Order 15498 of November 28, 1911, to read Twp. 10 instead of Twp. 9, C.P.R. Spur Order.

15849-50—January 25—Authorizing C.P.R. to construct spur to premises of Redcliffe Realty Co. and Redcliffe Brick & Coal Co. in Sec. 5, Twp. 13, R. 6, West 4th M., Alberta, and for Quinlan-Carter Co., Ltd., on Lot Subdivision No. 21, in Block "E" of Sec. 17, Twp. 24, R. 1, West 5th, Calgary, Alta.

15851—January 25—Directing C.N.R. within six weeks from date to provide suitable undercrossing on farm of A. J. Hunter, Sleeman, Ont.

15852—January 25—Approving plans and specification of Morden drain to be constructed under track of M.C. Ry. in Twp. of Aldborough, County of Elgin, Ont.

15853—January 31—Amending Order 15802 of January 11, 1912, to read Lot 9, instead of Lot 11, Canadian Copper Co.'s spur.

15854—January 31—Naming express collection and delivery limits for town of Magog, Que.

15855—February 8—Extending for three weeks time for filing plans by C.P.R. for interlocker at Woodstock, Ont., required by Order 15451, November 7, 1911.

15856—January 31—Authorizing Smart-Turner Machine Co., Ltd., to construct travelling crane across G.T.R. siding at Hamilton, Ont.

15857—January 31—Directing that cost of gates at crossing east of Welland Station, Ont., on M.C.R. be borne as follows: 15 per cent. town of Welland, 10 per cent. town of Crowland, remainder by M.C. Ry. See Order 10568, February 26, 1910.

15858—February 1—Disallowing Supplement No. 1 to Boston & Maine Joint and Proportional Class Rate and Commodity Tariff C.R.C. No. 1219.

15859—February 1—Authorizing T.H. & B. Ry. to construct siding into premises of Armstrong Supply Co., Ltd., Hamilton, Ont. Rescinding Order 15745, January 23, 1912.

15860—January 31—Approving revised location of G.T.P.B.L. Co. Cutknife Branch, mileage 31.86 to 55.84, Saskatchewan.

15861—January 31—Directing that town of Simcoe pay G.T.R. 15 per cent. of cost of protection of crossing protection required by Order 15387, November 15, 1911, Norfolk St., Simcoe.

15862—February 1—Authorizing G.T.R. to construct siding into premises of Watrous Engine Works, Brantford, Ont. Rescinding Order No. 15255, October 11, 1911.

15863—Authorizing G.T.R. to reconstruct swing bridge over Richelieu River, mileage 8.75, 13th District, Quebec.

15864-65—February 1—Authorizing C.P.R. to open for carriage of traffic its Moose Jaw Southwesterly Branch near Moose Jaw, Sask., to mileage 27.4, and its Swift Current Southeasterly Branch near Swift Current to Neville, Sask., Mileage, 27.4, speed limit 15 miles per hour.

15866—February 1—Authorizing T.H. & B. Ry. to cross at grade Newport St., Brantford, Ont.

15867-68—January 29—15869—February 1—Approving location of C.N.R. through Twps. 10-11, Ranges 3-4, West 3rd M., Saskatchewan, mileage 25.38 to 51.68, Saskatchewan, and through Twps. 5-6, Ranges 26-28, West 4th M., Alberta, mileage 120.27 to 141.09.

15870—February 1—Approving location of C.N.O. Ry. station grounds at Richmond, Ont., Twp. of Goulbourn.

15871—January 27—15872—January 29—Authorizing C.N.R. to cross thirteen highways with its Calgary Southerly Line, Alberta, and ten highways on its Swift Current Line.

15873—January 30—Authorizing C.P.R. and Montreal Street Ry. to operate over crossing at Papineau Ave., Montreal, without coming to stop, acct. interlocker completed.

15874—January 27—15875—January 31—Authorizing C.P.R. to construct spur for McGillivray Creek Coal & Coke Co., Ltd., near Coleman, Alta., and spur for Nicola Valley Pine Lumber Co., near Canford, B.C.

15876—January 30—Authorizing C.N.R. to open for carriage of traffic its Rossburn Extension from Hamton to a connection with main line east of Canora, 15 miles.

15877—February 1—Approving location of C.N.O. Ry. station grounds in village of Newburgh, Ont.

15878-79—January 27—Approving location of C.N.R. through Twps. 9-6, R. 25, West 4th, Alberta, mileage, 106.37 to 120.27, and through Twp. 52, R. 24, West 4th M., Alberta, mileage 44.40 to 45.97, Province of Alberta.

15880—January 31—15881—January 29—Authorizing C.N.R. to cross with its Grosse Isle Branch, Manitoba, fifteen highways in R. M. Woodlands and with same branch nine highways in R. M. Rockwood, Manitoba.

15882—January 26—Authorizing C.N. Pacific Ry. to use crossing for construction purposes only until June 30, 1912, under further condition that all trains be brought to a stop subject to terms of Order 14577 (C.P.R. Mission Branch crossed by C.N.P.).

15883—January 27—Approving location of C.P.R. station on Yahk Branch five miles north of Kingsgate, B.C., station to be standard portable.

15884—January 27—Authorizing C.P.R. (G.B. & S. Ry.) to construct farm crossing at mileage 25, in Lot 3, Con. 6, Twp. of South Orillia, County of Simcoe, Ontario.

15885—February 1—Relieving C.P.R. from further protection at crossing in the village of Blind River, Ontario.

15886-87—February 1—Approving change in location of C.P.R. stations at Ste. Rose, County Laval, Quebec, and at St. Martin Jct., Parish of St. Martin, Quebec.

15888—February 2—Authorizing C.P.R. to construct spur for Construction & Paving Co., North Toronto, Ont.

15889-90—January 30—Authorizing C.P.R. to use and operate bridge over Scugog River, near Lindsay, Ont. (G.B. & S. Ry.), and to use and operate ten bridges on G.B. & S. Ry. between mileages 20.64 and 81.13, Ontario.

15891—January 30—Authorizing C.P.R. to operate its trains under bridge 4.37, Walkerton S.D., Ontario.

15892—January 27—Authorizing C.P.R. and G.T.R. to use and operate crossing of G.T.P.B.L. Co. crossing C.P.R. Pheasant Hills Branch account interlocker completed, Saskatchewan. See Order 11627, September 9, 1910.

15893—January 27—Certificate of correction to G.T.P.B.L. Co. plan of location Tofield-Calgary Branch.

15894—January 29—Authorizing G.T.P.B.L. Co. and C.N.R. to use interlocking plant at crossing in N.E. ¼ Sec. 20, Twp. 38, R. 26, West 2nd, at Dana, Sask.

15895—January 29—Directing Pere Marquette Ry. to erect and maintain fences in middle part of Lot 14, Con. 2, Colchester South, owned by James Murray, County of Essex, Ontario.

15896—January 31—Authorizing Twp. of Gloucester, County of Carleton, Ont., to construct Queen Mary St. over tracks of C.P.R. (Prescott S.D.).

15897—February 2—Authorizing C.P.R. to open for carriage of traffic its second track from Romford Jct. to Crete, on Cartier S.D., Ontario.

15898—February 3—Approving location of Lake Erie and Northern Ry. from Grand River in city of Brantford to village of Port Dover, in County of Norfolk, Ont.

15899-15900—February 1—Approving standard clearance of G.T.P. Ry. coal chutes, also for new ice house for use on side tracks.

15901—January 1—Relieving C.N.R. from further protection of highway between mile post 475 and 476 east of Aberdeen, Sask.

15902—January 30—Amending Order 15692, December 27, 1911, by providing that bell be installed before June 29, 1912. C.P.R.

15903—February 5—Extending until March 15, 1912, time for installation by G.T.R. of interlocking plant at Nipissing Jct. crossing C.P.R. to connection with T. & N.O.

15904—February 6—Approving revised location of C.N.O. Ry. through Twp. of Loughborough, County of Frontenac, mileage 164.59 to 164.76.

15905-06—January 27—Authorizing C.N.R. to cross public roads (two) on its Grose Isle Branch, in R.M. Rockwood, Manitoba.

15907—February 5—Authorizing C.N.R. to cross with its Strathcona-Camrose Branch seven highways in Alberta.

15908—February 6—Further extending until June 30, 1912, time for completion by C.P.R. of work required by Order 10462, May 3, 1910.

15909—February 6—Authorizing C.N.R. to construct spur line from its Vegreville-Calgary Line into premises of Rose Deer Coal Mining Co., Ltd.

15910—February 7—Amending Order 15709 of December 29, 1911, by striking out word "two" and substituting word "three."

15911—February 5—Authorizing C.P.R. to construct across and divert highway at mileage 210.03 at west boundary of Sec. 18, Twp. 18, R. 16, West 3rd M., Saskatchewan.

15912—February 7—Authorizing C.P.R. to construct spur in Moose Jaw, Sask., for Saskatchewan Flour Mills Co., Ltd.

15913—February 6—Amending Order 15816, January 17, 1912, by adding words "and registered in the Land Titles Office for the North Alberta Land Registrar under No. 5010 Day Book A.1" at end of recital to said Order.

15914—February 6—Authorizing V.V.E. & N. Co. and Vancouver, Fraser Valley & Southern Ry. Co. to use and operate crossing near Ardley, B.C., account interlocker completed.

15915—February 5—Dismissing application of city of St. Thomas, Ont., to construct Inkerman St. across G.T.R.

15916—February 5—Removing speed limitation on G.T.P.B.L. Co. Yorkton Branch from Melville to Canora, Sask. Order 14241 dated July 17, 1911.

Volume 22. Toronto, February 22, 1912

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The Canadian Engineer

An Engineering Weekly

THE ZINN BUILDING.

By T. KENNARD THOMSON, Consulting Engineer.

The Zinn Building is located at the southeast corner of 25th Street and Eleventh Avenue, and is a fine 11-story structure designed for and built by the Simon Zinn Company, manufacturers of fancy metal goods, as well as private offices, requiring, therefore, very heavy floor construction, the floors being designed for 250 pounds live load per square foot. About three-quarters of the basement is on the street level, while the engine room floor was carried down to 11 ft.

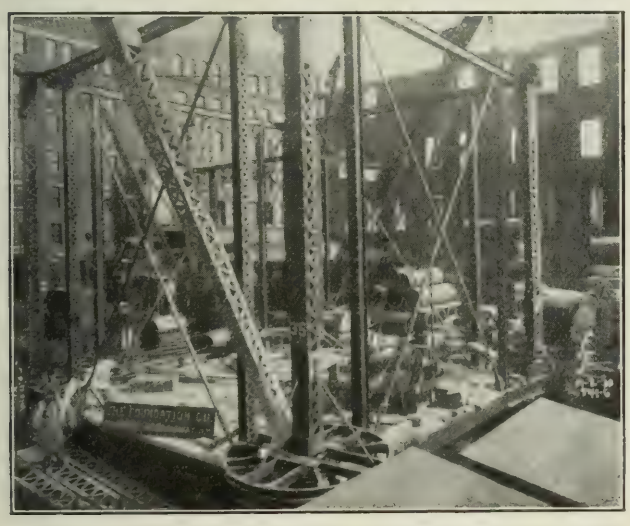


Fig. 1.—Four-Masted Steel Derrick.

2 in., and the boiler room and coal vaults to 15 ft. 2 in., the latter being under the 20-foot side walls on Eleventh Avenue, the lot being about 100 ft. by 100 ft.

This building leads the way for a radical improvement of the buildings in this valuable neighborhood.

In September, 1910, the writer reported to Messrs. Edward I. Shire and Lewis R. Kaufman, the architects for this building, his opinion on the proposed plans for the foundations, having previously received from the architects the results of the wash borings taken by Messrs. Phillips & Worthington. The two following tests give a good idea of the sixteen borings that were made:—

Test No. 2.—Zero equals 2 in. above curb A:

0′	0″	to 9′ 6″	Fillings.
9′	6″	to 31′ 0″	Sand and gravel.
31′	0″	to 43′ 4″	River mud.
43′	4″	to 45′ 4″	Sand and gravel to rock.

Test No. 8.—Zero equals 5 in. above curb:

0′	0″	to 17′ 4″	Fillings.
17′	4″	to 33′ 8″	Sand and gravel.
33′	8″	to 50′ 2″	River mud.
50′	3″	to 67′ 10″	Medium sand to rock or boulder.

In short, the site was "made ground" over the river silt, or mud, the filling consisting as usual of a little bit of everything, including boulders, sunken timbers, &c., which we afterwards found to be correct.

The "filled in" portion extended from the street level down to from 8½ to 18 feet below the curb, while the borings indicated that the river mud or silt extended from 14 ft. 8 in. to 33 ft. 6 in., or a variation of nearly 17 feet. It is not conceivable that the river silt was originally so much out of level, so the inference is that the sand, &c., sank into the silt, displacing it in places and forcing the adjoining portions to a higher level.

This is the regular Hudson River silt, and is a very much more treacherous material than the so-called New York quicksand which overlies the hardpan in the whole lower portion of Manhattan Island.

Under these circumstances the writer was very strongly of the opinion that the only really reliable foundation for this building would be pneumatic caissons, and the way the caissons acted while being sunk confirmed this opinion most decidedly.

Fig. 2.—Showing Two Four-Masted Steel Derricks. Steel Forms used for Building up Cylinders—Collapsible Steel Shafts Inside of Steel Forms. Wooden Cofferdams, Used where Concrete Stopped Below Ground. Pile of Cast Iron Blocks Marked "B" Used for Weighting Down Caissons. Each Block Weighs 1½ to 2¼ Tons.

In addition to the very treacherous nature of the soil that repeatedly "held a caisson up" and let it drop to the deck without warning, there is the fact that a subway will probably be built up Eleventh Avenue some day, which would tend to lower the water below the tops of any wooden

piles. The writer, having previously underpinned a building which had been built on piles 30 feet long, which, when cut off and capped, were entirely under standing water, but after the construction of a railroad tunnel were found to be free from water from top to bottom. It is well known, of course, that wooden piles have lasted for centuries in good condition when driven in water-bearing soil and kept submerged, but that the same piles would rot very quickly if the water were drawn off.

Besides, it would be almost impossible to drive wooden or concrete piles to rock on account of the sunken timbers, boulders, &c., which were indicated by the borings and afterwards removed through the air chamber of the caissons without going to such expense that there would be very little difference between the cost of the pneumatic caisson and the less reliable foundations.

The owners, therefore, decided to use caissons and accepted the tender of the Foundation Company for thirty-four circular caissons to be carried to bed rock for the lump sum of $82,500, which sum included the engine and boiler rooms and coal pocket walls, floor, &c., below the curb line.

There are 15 caissons of 6′ 6″ diameter
3 " 6′ 10″ "
7 " 7′ 6″ "
8 " 8′ 0″ "
—
or 34 in all

These caissons all had a steel working chamber, sides and roof, ⅜-inch thick.

The concrete being started on the top of the roof or deck, was built up about 20 feet at a time inside of removable circular metal forms. As soon as this concrete had set hard, excavation and sinking would be started and carried

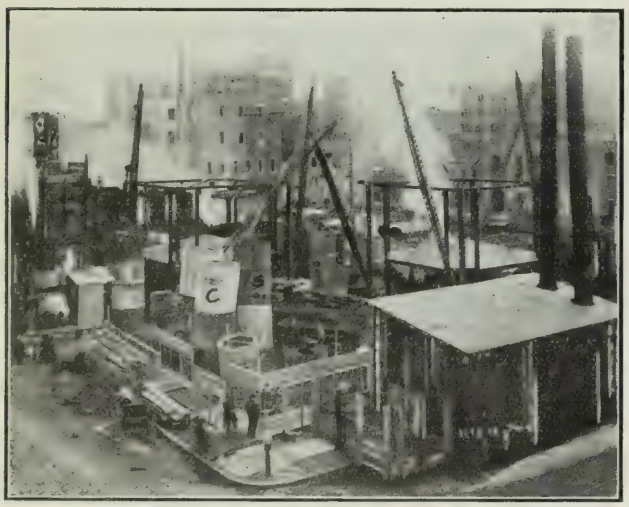


Fig. 3. Showing operation on November 15, 1910, also concrete mixer. "S" steel "Form" or shell removed before sinking. "C" Wooden Cofferdam.

on until the top of the concrete had nearly reached the surface of the ground when the men would be taken out and placed elsewhere while another "build up" of concrete was being put on. The pumping of compressed air had to be kept up of course all the time; the necessity for which was shown when the gauge tender allowed the air pressure to lower, which resulted in the air chamber being filled with sand to the deck when the cutting edge "ran away," of which more will be said later.

The working shaft for men and material was also formed by collapsible shafts which, however, were left in place until the sinking was finished and the air chamber had been filled with concrete, so that nothing but concrete was left from the deck to the base of the column base or grillage. The concrete was made of one part of Portland cement, three parts of sand, and five parts of broken stone or gravel.

Some trouble was experienced in getting the concrete to set up quickly, due partly to the season of the year and other causes. The concrete eventually set up hard but caused more or less delay waiting for it to do so before sinking could be resumed. Considerable sand was used from the Woolworth Building, Broadway and Park Place;

Fig. 4. Showing work on December 29, 1910, with grillage on Caisson in foreground.

this sand contained more or less clay and other impurities but gave a higher tensile test than the finer "Cowboy" sand.

Dr. Charles F. McKenna made the chemical and tensile tests and reported in favor of the Broadway sand.

The contract was let on October 8th and work at once started, although some of the old buildings had not been entirely removed.

The caissons were sunk in the following order:—

No. 1	sealed on	November	21st	at a depth of	—42.5 feet.
" 3	"	"	25th	"	—52.6 "
" 2	"	"	29th	"	—46.8 "
" 21	"	"	29th	"	—55.4 "
" 31	"	"	30th	"	—54.7 "
" 7	"	"	30th	"	—43.3 "
" 16	"	December	1st	"	—60.8 "
" 20	"	"	1st	"	—51.2 "
" 13	"	"	3rd	"	—46.0 "
" 33	"	"	3rd	"	—66.3 "
" 17	"	"	6th	"	57.2 "
" 19	"	"	7th	"	51.9 "
" 27	"	"	8th	"	54.5 "
" 32	"	"	13th	"	61.2 "
" 26	"	"	15th	"	50.1 "
" 8	"	"	15th	"	51.9 "
" 25	"	"	17th	"	53.4 "
" 9	"	"	17th	"	54.7 "
" 34	"	"	18th	"	76.9 "
" 24	"	"	21st	"	66.1 "
" 10	"	"	23rd	"	58.2 "
" 18	"	"	24th	"	61.2 "
" 14	"	"	25th	"	54.3 "
" 15	"	"	27th	"	54.2 "
" 30	"	"	28th	"	69.9 "
" 11	"	"	29th	"	—60.0 "
" 28	"	"	31st	"	—64.7 "

			1911.		
" 12	"	January	3rd	"	—59.3 "
" 29	"	"	3rd	"	—64.4 "
" 4	"	"	5th	"	—57. "
" 5	"	"	6th	"	—59.9 "
" 6	"	"	10th	"	—62.7 "
" 22	"	"	13th	"	—64.1 "
" 23	"	"	15th	"	—60.3 "

The only remarkable or unique feature of this job was the number of times the caissons ran away—or got beyond control and sank in the silt up to the deck. This happened so often that whenever a caisson was undermined, ready for sinking, the entire gang came out instead of staying in the air chamber as usual. Otherwise there would have been much loss of life.

This resulted in a loss of about 8 or 10 hours each time, as it, of course, took time to send a man down the shaft with a pail to clear away enough material to make room for the bucket and gang.

The following are the caissons that ran away:—

Caisson No.	33—Dec. 1st, 1910		
"	" 34 " 6th		
"	" 34 " 9th		
"	" 34 " 10th	(Broke 35 ft. above C.E.)	
"	" 26 " 15th		
"	" 34 " 15th		
"	" 10 " 15th		
"	" 24 " 17th		
"	" 30 " 27th	Full of water.	
"	" 28 " 28th		
"	" 11 " 28th		
"	" 28 " 30th	Dropped five feet.	
"	" 29—Jan. 3rd, 1911.	Dropped five feet.	
"	" 12 " 3rd	Dropped five feet.	
"	" 4 " 5th	Dropped five feet.	

Fig. 5. On December 21, 1911, showing grillage concrete in place.

Caisson No. 34 on December 10th sank suddenly while an inclined timber brace was in position. This brace toed against Caisson No. 30 and was acting against the top of No. 34. The result was that No. 34 was broken in two about 8 feet below the ground, or 35 feet above the cutting edge, requiring the removal and rebuilding of the upper portion which was, of course, then as good as the original; the cost of the accident being borne by the contractor, as a matter of course.

A new method of filling the working chamber was proposed and adopted by the writer in view of his experience in removing caissons already sunk where he had found that concrete "benched" and therefore put in rather dry was very poor, and concrete put in very wet was apt to shrink from one-half to one inch leaving a space between the deck and concrete.

This shrinkage appears to go on for 12 to 18 hours while the concrete is setting and drying, so on the Zinn Building he had the concrete placed in the working chamber as wet as possible up to about 10 inches of the deck and then allowed to set under air pressure for about 15 hours, when the

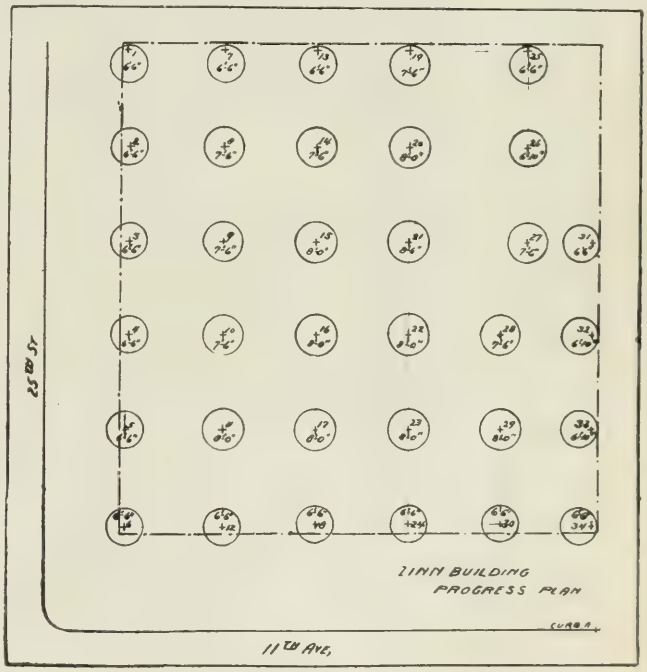
Fig. 6. Showing Wooden Cofferdams on Caissons on south-west corner.

lock was taken off and wet grout dumped from the top of the shaft, followed rapidly by very wet concrete.

This is the cheapest and best way of filling the working chamber—the only care required is to see that there are pipes or other means of escape for the air under the deck.

The compressed air should be left on for at least 18 hours and the concrete pushed as rapidly as possible after taking the air off.

As already intimated, the building was built by and for the Simon Zinn Company, whose architects are Messrs. Edward L. Shire and Lewis R. Kaufman.



Progress Plan.

The Hay Foundry Company erected the steel work, and the Foundation Company the caisson and foundation work, and Jacob Zimmerman was the general contractor; the writer being the Consulting Engineer to the owners on the foundation work.

SUBMERGED CONCRETE WORK.

A method of constructing submerged concrete work which is required to sustain heavy loads, has been brought forward by Mr. J. H. Tromanhauser, of Toronto. In this article we present a method of constructing light-house foundations, etc., by this method, which is suitable for exposed situations.

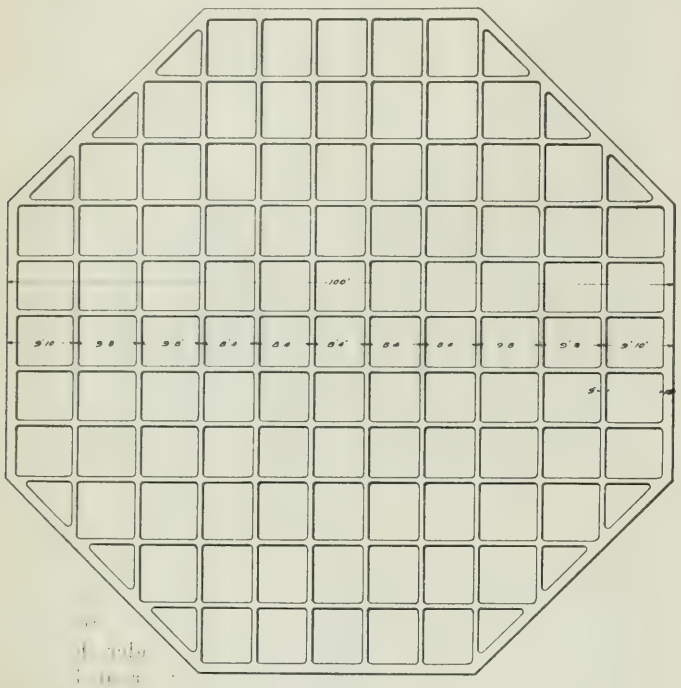


Fig. 1.

This method is an advance over the previous means of erecting acqueous concrete work in as much as varying depths do not greatly increase the difficulties of construction. The structure is erected on the nearest convenient shore, and, when sufficiently set, is skidded into the water and towed to the desired spot. When the wooden bottom is removed the honeycombed structure sinks.

This pontoon may be made to any depth to suit the depth of water. The displacement of this pontoon per foot submerged = 8,318 cubic feet = 260 tons at 62½ pound water pressure.

This foundation may be towed into position, and sunk securely upon the sea bottom so quickly that it is hardly possible to conceive conditions of tide, cave or wind, where this could not be successfully accomplished.

Usually, the sea bottom is so near a good general level, and also, so compact, that in most cases, this wide structure could be safely sunk directly upon the natural bottom without any artificial preparation whatever. This is frequently done with wooden cribs for lighthouse and other foundations, and with a heavy, thoroughly-bridged concrete structure the work of building, sinking and ballasting would be simple, safe and economical, compared with the same operations with any other materials or methods.

In case the natural sea bottom was such as to render it unsafe for supporting the structure, then, of course, an artificial support would have to be built, but just what methods should be followed in the construction of the foundation, is a question which could only be determined after a full and complete knowledge of all the local conditions has been ascertained.

The design of foundation here illustrated, will float with about 52 per cent. of the height of its concrete walls above the surface. Therefore, a structure with walls 50 ft. high may be built and floated into position in less than 25 ft. of water. This means that a concrete section designed for a 40 ft. depth of sea can be built in 25 ft. of water, and still have 10 ft. of its walls projecting above the surface to allow for settlement into the sand and mud after the pontoon floor has reached contact with the sea bottom.

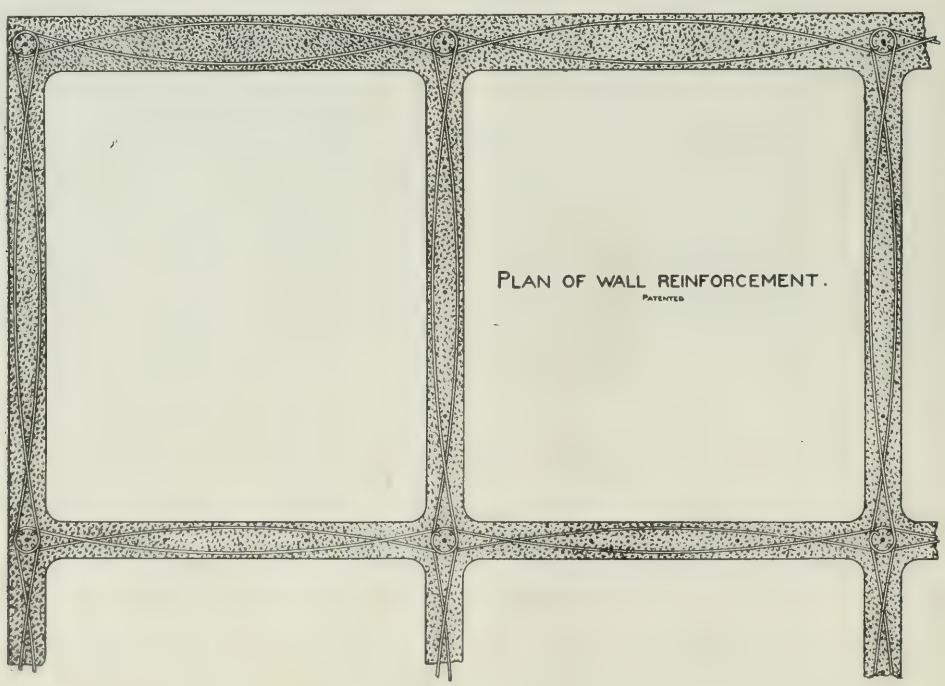


Fig. 2.

Fig. 1 is a top view of Mr. Tromanhauser's patent pontoon. This is octagonal in shape, one hundred feet across. A water-tight wooden bottom is secured to the lower end.

Fig. 2 shows the method of placing the reinforcement steel in the compartment walls, and Fig. 3 represents a stack of the wall truss bars bent to shape ready to be built

into the concrete. These bars are of square steel, with the ends bent in hook shape to give secure anchorage in the concrete. They are built into the walls in pairs, as shown in Fig. 2, and give the walls not only great bridging strength, but also truss them both ways against side or lateral strains.

The size and spacing distance of the truss bars would depend upon circumstances, as a structure for deep water would need greater strength than one for shallow depths, but in all cases the walls must be built or trussed to resist lateral strains from both sides, for, when the concrete sections are floating the outer walls are exposed to a heavy in-

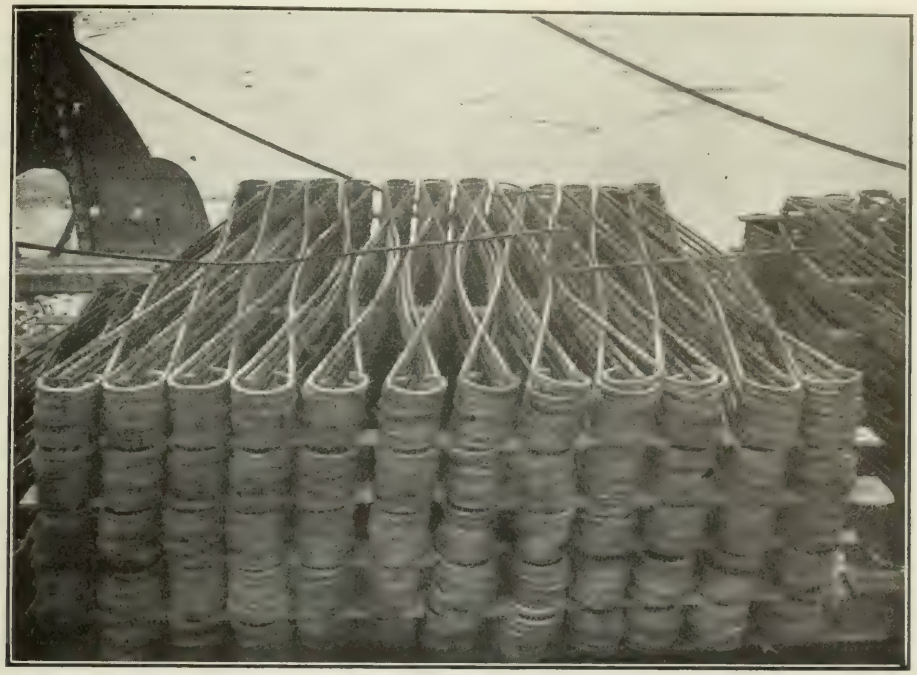


Fig. 3.

At all intersections of the walls the hooked ends encircle vertical round steel bars, which feature practically links the entire wall structure into an unbroken chain of reinforcement.

ward hydrostatic pressure, but when sunk and filled with ballast and water, this is reversed and the heaviest pressure is from the inside. The system of reinforcement is fully covered by patents.

THE GROWTH OF THE WEST.

The end of a calendar year, as a rule, is a signal for municipalities to strike and publish a balance. A compilation of municipal and provincial statistics of such items as are of interest to the engineer will show in a tangible manner the growth of Western Canada.

According to the official figures issued by the census commissioner, the population of Western Canada has increased in ten years 174 per cent., as compared with an increase of 17 per cent. in the East. Of the western provinces Alberta has made the greatest gain; Saskatchewan is a very close second and British Columbia and Manitoba both have records that compare favorably with any eastern province. In the decade under review the eastern half of the Dominion has added to its population 721,722 souls as compared with 1,045,717 by the west. Saskatchewan has added the greatest number and of these most of them belong to the farming community which speaks well for the future of that province. The following table shows the changes in population within the period 1901-1911 by provinces divided into eastern and western sections:

West—	1911.	1901.	Increase.	Per cent.
Alberta	372,919	73,022	299,897	424.0
British Columbia	362,768	178,657	184,111	103.0
Manitoba	454,691	255,211	199,480	80.0
Saskatchewan	453,508	91,279	362,229	386.0
	1,643,876	598,169	1,045,717	174.0
East—				
New Brunswick	351,815	331,120	20,695	6.0
Nova Scotia	461,847	459,574	2,273	0.0
Ontario	2,529,902	2,182,947	346,955	13.0
Prince Edward Island	93,722	103,259	—9,537	—
Quebec	2,000,697	1,648,898	351,799	21.0
	5,437,983	4,725,798	721,722	17.0
Total for Canada	7,081,869	5,323,967	1,767,439	33.0

Twelve representative cities of the Canadian West show a gain of population within five years of 93.6 per cent. and a gain in ten years of 301.5 per cent. These are official figures and do not include all the people that, properly speaking, belong to the community of which the cities named constitute the real city centre. Edmonton's figures for instance do not include Strathcona, which is practically a part of that city. Those of Winnipeg do not include the populous suburbs of St. James, St. Boniface, Norwood and other communities that adjoin its borders. Strictly speaking, therefore, the actual increase of the urban population is greater than the figures represent.

In the case of practically every city, with the exception of Regina, complaints are made as to the inaccuracy of the official figures. Municipal censuses have been taken which show larger populations, but inasmuch as the complaints are general, and that municipal recounts have not been made in every case, the official figures have been used to

show the growth taking place in western cities, as exemplified in the table following:—

	1901	1906	1911	5 yrs.	10 yrs.
Brandon	5,620	10,408	13,837	32.9	146.2
Edmonton	2,626	11,167	24,882	122.8	847.5
Calgary	4,091	11,976	43,736	265.1	969.0
Fernie	1,873	3,913	3,140	*19.6	66.6
Lethbridge	2,072	2,313	8,048	247.9	288.4
Medicine Hat	1,570	3,020	5,572	84.9	254.9
Moose Jaw	1,558	6,249	13,825	121.2	787.4
Portage la Prairie	3,901	5,106	5,885	15.2	50.8
Prince Albert	1,785	3,005	6,254	108.1	250.3
Regina	2,249	6,169	30,210	389.7	1243.2
Saskatoon	113	3,011	12,002	298.6	10521.2
Winnipeg	42,340	90,153	135,430	50.1	219.8
	75,418	156,490	302,827	98.6	301.5

* Decrease—due to miners' strike.

An increase in population always precedes an increase of building, and the quality of the building, structural and architectural, depends upon the monetary standing of the erectors.

With an increase of 174 per cent. in population during the past decade, has come an increase of 51.12 per cent. in building operations in five years in the western sections. This increase is made up thus:—

	1907	1908
Brandon	$ 704,209	$ 293,047
Calgary	2,094,264	1,004,520
Edmonton	2,280,210	2,549,847
Fernie	250,000	250,000
Lethbridge	205,000	369,145
Medicine Hat	150,000	138,072
Moose Jaw	546,424	430,925
Portage la Prairie	257,875	120,000
Prince Albert	300,000	200,000
Regina	1,177,840	516,656
Saskatoon	277,211	115,625
Winnipeg	6,309,950	5,513,700
Total	$14,553,064	$11,501,037
Compared with previous year per cent...		— 20.91

+ Increase. — Decrease.

This enormous increase and migration is due to a large extent to the railway companies which are opening new districts with the extension of their steel. The figures of mileage increase for three provinces are as follows:—

Year	Manitoba	Saskatchewan	Alberta
1893	1,470	748	807
1894	1,471	965	807
1895	1,472	965	807
1896	1,470	965	807
1897	1,570	965	807
1898	1,592	965	807
1899	1,603	993	908
1900	1,815	993	908
1901	2,056	1,107	978
1902	2,128	1,102	978
1903	2,224	1,117	978
1904	2,364	1,180	1,020
1905	2,672	1,523	1,020
1906	2,823	1,973	1,200
1907	3,074	2,025	1,323
1908	3,110	2,081	1,323
1909	3,205	2,630	1,323
1910	3,526	3,350	1,774
1911	3,796	4,202	2,111

The increase in mileage of the various companies for two years reads thus:

1910	Man.	Sask.	Alta.	Total
Canadian Pacific Railway	1,529	1,750	1,270	4,549
Canadian Northern Railway	1,531	1,183	219	2,933
Grand Trunk Pacific	304	417	285	1,006
Great North	162	.....	.....	162
Total	3,526	3,350	1,774	8,650
1911				
Canadian Pacific Railway	1,595	2,041	1,273	4,909
Canadian Northern Railway	1,735	1,610	393	3,738
Grand Trunk Pacific	304	551	445	1,300
Great North	162	.....	.....	162
Total	3,796	4,202	2,111	10,109
Increase of 1911 over 1910	470	852	337	1,459

The Canadian Northern Railway has had a wonderful season of construction this past year. Four thousand four hundred and fifteen miles of Canadian Northern lines are now in operation west of the Great Lakes, and some additional lines are ready for operation as soon as inspection has been made by the railway commission. In the past summer 16,686 men were employed in Canadian Northern construction west of Port Arthur.

1909	1910	1911	Change
$ 350,120	$ 1,224,385	$ 1,108,129	— .094
2,420,450	5,589,594	12,709,478	+ 127.39
2,128,161	2,161,356	3,797,525	+ 75.70
1,374,700	325,000	150,000	— 53.84
1,268,215	1,211,310	1,033,980	— 14.69
228,168	427,140	450,000	+ 5.38
512,440	1,071,090	2,475,736	+ 131.09
195,000	362,500	300,000	— 17.12
141,810	662,475	921,145	+ 39.12
744,479	2,416,288	5,088,110	+ 110.59
1,002,055	2,817,771	4,920,000	+ 74.65
9,226,325	15,116,450	17,600,000	+ 15.77
$19,591,923	$33,385,359	$50,554,103	
+ 70.34	+ 70.41	+ 51.12	

Allowing an average wage of $2.50 per day the Canadian Northern Railway would have a monthly pay roll for these men of over one million and a quarter dollars. Every contract on the system from Montreal to Port Mann, opposite Vancouver and Batlott Sound, on Vancouver Island, has been let, and work has commenced on practically every section of the main line. Work on the section from Port Mann to the Yellow Head Pass will continue throughout the winter of 1911-12.

A great deal of winter work will also be carried on between Port Arthur and Sudbury on the eastern section.

It is difficult to compile figures of the standing of private concerns; although on the contrary companies of a semi-private nature, especially those dispensing public commodities are available. Of these are published the annual revenue from public water companies for four years operating in the western provinces:—

	1908.	1909.	1910.	1911.	Increase 1911 over 1910.	P.C.
Brandon	$ 38,819	$ 41,000	$ 34,650	$ 69,572	$ 34,922	100.93
Calgary	50,938	60,269	108,500	204,500	96,000	88.48
Edmonton	.....	.....	75,167	117,748	42,581	56.69
Fernie	.....	.....	20,500	17,804	2,696	13.15
Lethbridge	25,342	30,113	44,615	39,164	5,451	12.22
Moose Jaw	9,865	11,862	21,622	29,434	7,812	36.17
Portage la Prairie	14,031	17,623	26,780	36,061	9,281	34.76
Prince Albert	.....	.....	8,700	10,500	1,800	20,69
Regina	28,723	32,000	31,000	36,432	5,432	17.52
St. Boniface	7,627	8,845	11,340	13,500	2,160	19.11
Winnipeg	388,200	387,303	404,100	416,854	12,754	3.14

FORESTRY COMMISSION OF BRITISH COLUMBIA.

Owners of British Columbia timber will be interested in the legislation recently introduced in the legislature of that province, and based on the recommendations of the Forestry Commission made a year ago. The new policy is complete in detail and contains many and important departures from the present Act. The first great impetus was given to lumbering in British Columbia when the coalition government of 1901 prohibited the export of unmanufactured timber. This law worked out so well that it was adhered to, and Hon. W. R. Ross, in moving the second reading of the bill in the British Columbia legislature, thought so well of it that he declared it was a measure of the McBride administration. Premier McBride did not assume power until 1903, by which time the Americans were erecting mills in British Columbia, since they could not take the timber across the boundary line.

Features of the proposed legislation are as follows: Abandonment of the old method of staking. Hereafter, when timber is to be disposed of, a cruise will be made and tenders called for. Bonuses on licenses will be fixed according to conditions, principally at so much per thousand feet in addition to royalties. Existing timber leases when renewed will have new terms imposed in view of the terms and conditions imposed on other holders of timber so as to effect equality.

Timber held under license must all be surveyed by March 13th, 1918. If owners do not observe due diligence, the government may cause the survey to be made, charging owners therefor. Pulp timber concessions will remain the same until renewed. The licensing system will be retained, but conditions are altered. Terms are more favorable than in the case of timber for sawmill purposes.

Provisions are made for the creation of a forest reserve for the purpose if reforestation. Present scaling prices are interfered with. In districts where there are no official scalers, it is provided that unofficial scalers may be examined and licensed. No change is made in respect to timber marking and the manufacturing of timber within the province.

Special provisions are made for clearing away debris around camps, mines, mills, engines, and on rights-of-way of telephone, telegraph and other lines. All dangerous accumulations of debris must be disposed of, that forest fires may be prevented.

Logging operators may be required in the case of dangerous slash to make special provision for the prevention of fire when the minister requires it by cutting out fire lines. In respect to railways, a safety zone on either side is created to the width of two hundred feet, which must be kept clear of all combustible material. If this requirement is not observed, the government may do it, charging the expense to the company.

A forest fire protection fund is to be created. Owners will contribute a cent an acre, in addition to two and a half cents per thousand feet cut, against which the government will contribute dollar for dollar. Crown granted lands which do not pay royalty, are required to pay two cents an acre. Arrangement is made for automatic assessments for any time when the fund might prove inadequate. If the fund is too large, proportionate reduction will be made.

Railway tracks must be patrolled after the passing of each train, railway companies to bear the expense. A force of fire wardens must be maintained by companies during the construction of railway lines, and before running operations can be begun certificates must be obtained that debris has been cleared from the right-of-way. In case of fires started by railways through negligence a fine not exceeding one thousand dollars may be imposed. Provision is made for the use of preventive devices in the case of logging engines, locomotives, steamboats, portable engines, etc.

Contributors to the regular fund for fire protection who are placed at extra expense for protection and in fighting bush fires are recouped by the government to the extent of one-half the expenditure.

In regard to hand-loggers' licenses, the minister may be authorized to grant such in districts in which injuries to Crown or other timber lands is not likely to result, subject to certain exceptions. Classified increases have been made in the royalties on lumber cut in the province and intended for export. Otherwise royalties will be the same as at present.

Although the new timber policy has been announced but a few days, the Mountain Lumber Manufacturers' Association has taken prompt action. Fourteen members of the Association conferred with the lumber manufacturing colleagues on the coast, and asked the government to delay final consideration that they might be heard in regard to certain points of the bill.

The services have been secured of Mr. Overton Price, vice-president of the National Conservation Association of the United States, to assist the British Columbia Government in supervising the reorganization of forestry matters during the coming summer. Mr. Gifford Pinchot will also go to British Columbia if possible.

GOOD ROADS MEETING.

A convention of representatives of the various good roads associations of the Province of Ontario will be held in the York County Chambers, Adelaide Street, East, on February 26 and 27, for the purpose of formulating definite plans for road systems. The representatives will wait upon the Ontario Government during their stay in Toronto.

COST OF CONCRETE SEWERS.

By Victor Windett.

From a Paper Read Before the Western Society of Engineers.

COST OF CONCRETE PER CUBIC YARD, LABOR ONLY.

Diam. of Sewer.	Location.	Quantity of Concrete, Cu. Yds.	Cement, Sand, Stone to Mixer. Hrs.	$	Cement, Sand, Stone to Mixing Board. Hrs.	$	Machine Mixing. Hrs.	$	Hand Mixing. Hrs.	$	Delivery of Concrete Hrs.	$	Tamping. Hrs.	$	Plastering. Hrs.	$	Forms. Hrs.	$	Runways. Hrs.	$	Total for Machine Mixing. Hrs.	$	Total for Hand Mixing. Hrs.	$	Rate of Wages. $	Thickness of Wall. Cu. Yd. per Lin. Ft.
48″	Bl. Fce. Sewer, Ind. St. Co.	324	2.9	.65	...	...	1.8	.43	...	...	1.5	.34	.8	.17	...	...	1.2	.34	.5	.11	8.7	2.04	...	...	.24	8″ .36
57″	C. U. T. Ry., Clearing, Ill.	1,300	2.9	.58	2.9	.60	.9	.25	2.3	.59	1.5	.37	.2	.07	...	...	.6	.18	..	...	7.3	1.90	8.7	2.26	.26	8″ .48
60″	Open Hrth. Sew., Ill. St. Co.	263	...	...	3.7	.70	...	...	2.2	.46	1.8	.33	1.0	.25	...	...	1.5	.33	.4	.07	...	...	10.3	2.15	.21	10″ .57
60″	Open Hrth. Sew., Ill. St. Co.	237	3.5	.73	...	...	1.8	.42	...	...	.8	.18	.8	.18	1.2	.46	2.2	.67	..	...	9.1	2.19	...	...	.24	10″ .57
63″	C.U.T.Ry., Sew., Clring, Ill.	1,424	2.3	.48	3.7	.74	.9	.17	2.5	.59	1.5	.34	.4	.10	1.2	.43	.8	.23	..	...	7.1	1.75	10.1	2.43	.26	9″ .53
66″	C.U.T.Ry., Sew., Clring, Ill.	1,380	2.1	.45	3.71	.73	.8	.17	2.5	.59	1.5	.34	.4	.10	1.0	.39	.9	.23	..	...	6.5	1.68	10.0	2.38	.25	9″ .68
72″	Mill Sewer, Ind. St. Co.	1,592	2.3	.57	...	...	1.0	.30	...	...	1.0	.25	.7	.19	...	...	.6	.18	.4	.08	6.0	1.55	...	...	.26	12″ .82
72″	Mill Sewer, Ind. St. Co.	461	...	...	1.8	.35	...	...	1.5	.33	2.5	.55-Included			...	...	.9	.22	..	...	...	...	6.7	1.45	.22	12″ .82
72″	Mch. Mill Sew., Ind. St. Co.	1,438	2.4	.46	...	...	1.3	.32	...	...	2.5	.56-Included			...	...	.6	.18	..	...	5.8	1.52	...	...	.22	12″ .82
72″	Bl. Furn., Mill Sew., "	220	...	...	1.7	.34	...	...	1.3	.39	2.2	.52-Included			Av. of 10		1.8	.44	..	...	...	...	6.0	1.59	.25	12″ .82
	Total or Average	8,639	2.5	.54	2.9	.58	1.2	.28	2.0	.48	1.4	.32	.6	.15	.3	.13	1.1	.29	.4	.09	7.5	1.80	8.7	2.04	...	.. ..

COST OF CONCRETE SEWERS PER LINEAL FOOT.

Diameter	Location.	Length. Ft.	Depth. Ft.	Excavation. Hrs.	$	Sheeting and Bracing. Hrs.	$	Backfilling. Hrs.	$	Pumping. Hrs.	$	Total Trenching Hrs.	$	Concrete Hrs.	$	Superintendence and General Labor Hrs.	$	Total Labor. Hrs.	$	Materials $	Total Cost. $
48″	Bl. Fcs., Ind. Steel Co..	894	0.0 to 14.6	.3	.89	.2	.085	.6	.15	None		3.8	1.125	3.2	.74	.7	.355	7.7	2.22	....	....
57″	C.U.T.Ry., Clearing, Ill.	2,695	12.2	1.0	.37	1.0	.26	.5	.18	None		2.4	.81	3.9	1.00	.4	.15	6.7	1.97	....	....
60″	Open Hearth Sewer, Indiana Steel Co., Gary, Ind.	415	16.7	12.0	2.79	2.9	.60	1.9	.46	2.3	.51	19.6	4.36	5.3	1.23	3.4	1.43	28.0	7.02	....	....
60″	Open Hearth Sewer, Indiana Steel Co., Gary, Ind.	461.5	19.3	9.2	2.18	3.4	.77	1.8	.53	2.0	.41	16.4	3.89	5.7	1.22	2.0	.70	24.1	5.81	....	....
63″	C.U.T.Ry., Clearing, Ill.	2,666	13.7	1.3	.55	1.2	.34	.5	.19	.2	.05	3.2	1.13	4.4	1.06	.2	.16	7.8	2.35	2.06	4.41
66″	C.U.T.Ry., Clearing, Ill.	1,882	16.7	1.6	.71	1.4	.38	.9	.26	None		3.9	1.35	5.7	1.39	.8	.27	10.4	3.01	2.19	5.20
72″	Mill Sewer, Indiana Steel Co., Gary, Ind.	576.5	12.8	4.5	1.53	2.1	.52	.1	.03	.5	.13	7.5	2.21	5.3	1.15	1.3	.56	14.1	3.92	...	....
72″	Bl. Fces., Indiana Steel Co., Gary, Ind.	275.5	15.2	7.9	2.14	2.8	.80	.3	.17	1.4	.45	12.4	3.56	5.6	1.28	2.4	1.03	20.4	5.87	...	...
72″	Mill Sewer, Indiana Steel Co., Gary, Ind.	1,910	16.0	5.4	1.62	2.6	.79	.8	.24	.5	.12	9.3	2.77	5.3	1.36	.9	.50	15.5	4.63	...	...
72″	Merchant Mill, Indiana Steel Co., Gary, Ind.	1,213	19.7	10.8	3.04	4.7	.76	1.0	.71	.7	.16	17.2	4.67	5.7	1.29	.9	.54	23.8	6.50	...	...

DETAIL COST OF 6-FOOT CONCRETE "MILL" SEWER FOR INDIANA STEEL CO., GARY, IND.

Character of work	Total length of sewer: Costs Hours	Costs $	Work done 1910'-0" trench	Cost per: Unit of work Hour $	Unit of work $	Lin. foot sewer $	River extension and under 1st R. R. track: Costs Hour	Costs $	Per lin. ft. of sewer $	Under 2d R. R. track: Costs Hours	Costs $	Per lin. ft. of sewer $	Beyond R. R. tracks—free from obstructions: Costs Hours	Costs $	Per lin. ft. of sewer $
Excavation by Machine—															
Dismantling, loading, unloading, re-erecting	1,940	676.10					272	94.50		98	33.80		1,570	547.80	
Operation	2,993½	1,003.65	16,050 cu yds.				372½	145.60		177	48.25		2,444	809.80	
Dismantling and loading onto cars	383	133.35					54	18.70		19	6.65		310	108.00	
Total	5,316½	1,813.10	16,050 cu. yds.	.342	0.113	.93	698½	258.80	3.44	294	88.70	2.07	4.324	1,465.60	.80
Excavation by Hand—															
Sheeting and bracing placed	3,846	1,220.50	111,780' BM				597½	173.55		80	32.85				
Sheeting removed	1,219½	278.30	102,460' BM		2.71		Sheeting left in			7	2.90				
Steam pumping	428	109.85	1,700 cu. yds.				120	30.20		40	13.00				
Excavation	4,957½	1,281.25	1,700 cu. yds				614½	183.60		31	8.35				
Total	10,451	2,889.90	17,750 cu. yds.	.277	0.163	1.49	1,332	387.35	5.16	158	57.10	1.33	8,961	2,445.45	1.34
Backfilling by															
Machine	1,205½	375.65	14,900 cu yds.				90	28.75		41	13.10				
Hand and scrapers	355	99.35	350 cu. yds.										355	99.35	
Total	1,560½	475.00	15,250 cu. yds.	.305	0.31	.25	90	28.75	.40	41	13.10	.30	1,429½	433.15	.24
Trenching total	17,328	5,178.00	17,750 cu. yds.	.30	0.292	2.67	2,120½	674.90	9.00	493	158.90	3.70	14,714½	4,344.20	2.38
Concrete—															
Stone and sand from cars into concrete mixer	3,162½	810.15	1,592 cu. yds. of concrete in 1907'-0" sewer and 9 manholes equal to 34'-0 of sewer. Total equivalent sewer 1941'-0"	2.0	.51										
Cement from cars into concrete mixer	436½	96.45		.3	.06										
Mixer men	1,655	481.75		1.0	.30										
Wheeling concrete	1,660	401.90		1.0	.25										
Spreading and tamping	1,075½	296.55		.7	.19										
Forms	1,000	286.65		.6	.18										
Runways	535½	126.45		.3	.08										
Steam pumping	429	109.75		.3	.07		20	6.50		89	25.75				
Backfilling	433	114.50		.3	.07										
Masonry total	10,387	2,724.15	1941'-0"	6.5	1.71	1.40	798	227.60	3.04	376	118.65	2.75	9,213	2,377.90	1.30
General Expense—															
Cleaning up	118	52.30								24	6.85	.16	94	45.45	
Watchmen	716	160.60					73	17.15		74	15.40	.40	569	128.05	
Superintendence	932	738.10					192	173.20		48½	37.75		691½	527.50	
General expense total	1,766	951.00	"	.54	.60	.49	265	190.35	2.54	146½	60.00	1.40	1,354½	700.65	.39
Total labor	29,481	8,853.15	"	0.30	5.57	4.56	3,183½	1,092.85	14.58	1,015½	337.55	7.85	25,282	7,422.75	4.07

Total Length....1,941.0 ft.
Cement, 1,292 bbls $1,744.88
Cement, per cu. yd of concrete.....0.81 bbl. $1.094
Cement, per lin. ft. of sewer.....0.67 bbl. 0.905

River Extension....75.0 ft.
Excav'n, 800 cu. yds. per cu. yd. $0.843
Concrete, 62 cu. yd., per cu. yd. 3.67
Cement, 104¼ bbls, $140.74.
Cement, per cu. yd..1.7 bbl. 2.40
Cement, per lin. ft...1.4 bbl. 1.83

Under 2d Track....4.30 ft.
550 cu. yds., per cu. yd.....$0.291
36 cu. yds. concrete..... 3.30
Cement, 40¼ bbls., $54.34.
Cement, per cu. yd..1.12 bbls. 1.51
Cement, per lin. ft..0.94 bbl. 1.27

Beyond Tracks....1,823.0 ft.
16,400 cu yds., per cu yd....$0.265
1,494 cu. yds. concrete..... 1.59
1,148 bbls., $1,549.80.
Per cu. yd.....0.77 bbl. 1.04
Per lin. ft.....0.63 bbl. 0.85

A REINFORCED CONCRETE FACTORY.

Recently at Cambridge, Mass., there has been completed a right-triangular shaped reinforced concrete factory, owned by the Cambridge Factory Trust, and occupied on the two upper floors by A. B. Smith & Company, manufacturers of cigars. The lower floor is occupied by stores. It will be noted from the accompanying illustration that the exterior of the building has a very dignified and refined appearance, while the interior is arranged for maximum efficiency. The design was made in accordance with plans and specifications of Monks & Johnson, architects and engineers, 7 Water Street, Boston, and the type of construction was adopted on account of its fitness for close quarters and other reasons. Mill construction was not considered.

Exterior View of Factory.

The engineers made estimates using both of these types of concrete construction and adopted the column and flat slab system, for it was found as cheap as the beam and girder type, besides offering the additional advantages of simpler forms, lower cost of automatic sprinkler installation, and better overhead shafting facilities. The forms for a beam and girder system would have been very complicated owing to the triangular shape of the building.

The factory is three stories high, with basement, with all floors and the frames of reinforced concrete, while the exterior between the pilasters is veneered with 4-inch red sand-struck brick. The longer side of the building is about 151 feet while the shorter sides are 87 feet and 132 feet. The lower floor is devoted to stores, with entrance on Massachusetts Avenue. The upper floors are devoted to cigar manufacturing, the entrance to these being by a stairway and an elevator in the right-angled corner of the building.

The general impression that reinforced concrete structures have a displeasing effect is being diminished by such structures as this Cambridge cigar factory. The lines of the building are exceptionally well kept, the height seeming more than it really is, due to the continuation of the pilaster lines to the top. This is effected by means of corbels and small marble panels at the top. The entire width between the pilasters is taken up by the large window area, beneath which is 4-inch brick veneering with concrete panels in the centre and below each of the four respective windows. The entire cornice is of concrete, while a concrete coping rests on the 8-inch thick brick wall running around the top of the building. The artistic effect is excellent, and the building is a very creditable addition to the community and would not be recognized as a factory.

The interior arrangement of the building has been planned for maximum efficiency. All of the floors are of 7-inch concrete, the first floor having a terrazzo finish. There are three rows of columns on each floor running parallel to the long side of the building with 18-feet bays each way. The window area is about 75 per cent. of the wall area, this being secured with windows 7 feet 6 inches high running up to the floor slab. The windows have wooden frames and sashes and are pivotted at the top, while the lower portions are double hung. The general width of the window is 15 feet 10 inches. An automatic sprinkler system is installed throughout the building. The columns rectangular in cross section vary from 20 inches to 30 inches in the basement and first floor, to 16 inches by 30 inches on the second and third floors. The basement columns are reinforced by twelve 1-inch diameter rods with ¼-inch hoops placed 12 inches on centres. The reinforcement of the first, second, and third floor columns consists of ¾-inch rods, eight being in the first floor columns, and this number decreasing by two for each successive floor. Hoops ¼-inch diameter are also spaced similarly to the basement columns.

The reinforcement of the floor slab consists of a layer of rectangular rods at the top and a layer of diagonal rods at the bottom, the latter having a slight lap. The rectangular rods lap over column heads with laps ranging from 5 feet 4 inches to 8 feet 4 inches. This method is slightly different from the ordinary, and avoids four layers common in most flat slab systems. The floor load was estimated at 125 lbs. per square ft., and the mixture of concrete used at the column heads was quite rich, being 1:1-1/2:2. It is stated that a saving in steel was made by this method.

Interior View of Factory.

The entire building, which was designed with the future intention of putting on another storey, rests on concrete footings placed on hard pan. These footings are generally 9 feet 6 inches by 8 inches. The elevator well is of terra cotta, while the chimney is of brick, and at present there is a temporary roof of wood with plastic slate.

Although this building might properly be stated to be "absolutely fireproof" a serious loss might occur by the burning of the combustible contents. To prevent such an occurrence about 340 Grinnell automatic sprinklers have

been installed on a wet system put in in accordance with specifications of the General Fire Extinguisher Company of Massachusetts. The interior view shows clearly the method of suspending the sprinkler pipes, and the advantage gained in this connection from using a flat slab system.

The entire building was erected by the Concrete Engineering Company of Boston, in accordance with plans and specifications of Monks & Johnson, the architects and engineers. The concrete was mixed on the ground in a 1-yard Ransome mixer that discharged directly into Ransome dump buckets which were hoisted to the top of the wooden tower where the concrete was chuted directly to the forms.

PIPE SYSTEMS IN STREETS.*

By Charles E. Bolling.

The purpose of this paper is to call attention to pipe systems in streets in connection with roadway improvements.

At this period of progression, when so many people are aroused and interested in the advancement and improvement of our country, not confined to localities, but extending over the whole of the United States; when the attention of our progressive citizens is being attracted to the many and various plans and schemes for greater development of our resources, as shown by numerous conventions and assemblies where we are enlightened by many instructive and able articles and discussions upon the different subjects for our further development, I feel confident that no one subject has more aroused the interest of the people than the importance and necessity of constructing highways, roads and streets.

Much valuable information and instruction has been freely given as to the making and maintaining of good roads and streets. It appears to the writer of this article that some important economical features in road construction have been overlooked and have not received proper consideration. Therefore, as briefly as possible, I shall call attention to what I regard, after many years of experience, as being in the line of economy in road construction and maintenance, which is, as the title of this paper shows, the necessity of underground pipe construction before making streets and roads. Especially do I regard it as being worthy of consideration in growing cities, towns and suburban sections. No matter how carefully a road or street may have been built, it is destroyed and ruined subsequently by the introduction of pipes, such as sewer, gas, water, etc., and their connections, and whenever installed the results are a series of ruts and mounds in the street. I have never seen a street properly repaired after being cut up for pipes.

In communities that are improving and developing, the first cry is for good roads. Then later follows the demand for water, sewerage and light. After a while these necessary improvements are made—most often at long intervals. With each pipe construction the street is cut into, again injured, and finally has to be entirely reconstructed. It is recognized that all of these conveniences are paid for by a tax upon the property abutting the street, whether the improvements are made by the city, or town, or by a private company, and, whenever a section is sufficiently built up to demand these necessities and comforts, sewer and pipe lines are constructed and connections made to the improved or occupied lots scattered along the line of the highways. The vacant lots usually do not have the connecting pipes from the main lines extended to them. And then connections are made for sewer, gas and water, from time to time, as each lot is built upon. At least such is the custom in this city.

The writer wishes, therefore, to bring to your attention the importance of having all of these connecting pipes extended from the main pipes to the vacant lots at the time the main sewer and pipes are laid in the street. This, however, is often attended with difficulty, on account of uncertainty as to what may be the future subdivision of the lots. Generally this subdivision can be ascertained quite closely by an examination of the recorded plats and the frontage of the improved lots and the connections adjusted accordingly. Assuming that the essential underground pipe connections are sewer, water and gas, that the block or square contains a frontage of 300 ft., that the subdivision into lots averages 30 ft., and that only ten of these lots have been built upon, there will be ten vacant or unimproved lots and ten unused connections. Basing the estimate of cost of such connecting pipes on that in a street 60 ft. wide, I find the average costs of connections in this city are as follows: Sewer connection, 10 ft. deep, $12.00; gas connection pipe, 2½ ft. deep, $6.00, and water connection pipe, 2½ ft. deep, $6.00, each of the latter having the necessary stop cocks at the curb line, making a total of $24.00 for each lot. Assuming the rate of interest upon the outlay to be 4 per cent., 96 cents would be the annual expense on this cost.

It is also the experience of the writer that in the communities where these conveniences, such as sewer, water and gas exist, the growth and improvement is rapid, and in a short time all the abutting lots are improved and occupied. Under the laws governing the city of Richmond, the cost of water and gas mains, as well as connections to same, are not charged to the abutting property, nor is the main sewer, but there is an annual sewer tax of ten cents for every foot of frontage in the street, and the cost of the sewer connection is paid by the lot owner only where the fixtures on the lot are connected, and the owner of the vacant lot does not pay for this connection to the sewer until it is used. The increased value of the abutting property, however, is so great, because of having the necessities and conveniences of sewer, gas and water, that the tax receipts are greatly in excess of the small annual interest on the cost of pipe connections. It is evident that this cost for pipe connections is warranted. In all cases where the street has already been paved or otherwise improved, the cost of making the pipe connection is at least 60 per cent. greater than in the unimproved street, and the restoration and maintenance of the paving of the street, in the end, amounts to double the original cost. Again, had these different pipes and pipe connections been constructed prior to paving the street surface, the opportunity would have been afforded for carefully treating the trenches and fills and thoroughly and properly preparing a road base.

The writer recognizes the fact that the time will never come when the streets of a city or town will not have to be cut into for repairs and various other purposes, and that to a large extent what he has brought to your attention applies to local conditions, as evidenced in his own long experience. But at the same time he feels assured that by consideration, co-operation and the construction of underground pipes prior to the surface improvement of a road or street, much money can be saved in construction, and especially in the maintenance, of both roads and streets.

This paper is intended only to apply to underground pipes used in municipal service and not to pipes for road drainage, which properly belongs to road construction.

* Paper presented before Section D of the American Association for the Advancement of Science at the annual meeting at Washington, D.C., Dec. 26-29, 1911.

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ENGINEERING ETHICS.

Too often we read in the papers that certain works for municipal corporations are inadequate in some respects for the part to be performed. Insufficient funds have been provided for thorough and efficient design, and as a result some part or parts, or even the whole, has had to suffer. The engineer is quick to criticize the city council when poor results are obtained by stating that he was handicapped through lack of sufficient money. In many cases this is true, but we must not lose sight of the engineer's initial responsibility in accepting the work with the knowledge of the facts.

In a recent investigation into the filtration plant of one of our large cities the consulting engineer for the work, in giving evidence before a court of inquiry, made the remark that in his opinion the city had obtained good value for the money expended. While this statement was true, it reflects little credit on the engineer. The point in the enquiry which appeared to be lost sight of was the fact that the sum voted for the completed plant was too small. The cost of the completed plant per million gallons of water treated is about two-thirds that of American plants under similar conditions. The reason for this low cost is plain from the facts brought out during the investigation. The pumping plant is too small, and compressed into a small building; little or no reinforcement was used for the concrete; lean-tos had to be erected to house part of the boiler plant.

The council and the Board of Control are blamed for this by reason of the small amount of money provided, and undoubtedly to this fact is due the above state of affairs. On the other hand, the consulting engineer, to be just to his client and to be fair to himself, should not take on work knowing that the sum appropriated for the design and construction is insufficient. It is his duty to inform his clients that he will not proceed with the design until sufficient money is provided for adequately covering the work.

If a bridge engineer were asked to design and construct a bridge to carry certain traffic for the sum of $10,000, and he knew it was impossible to erect such a bridge for any amount less than $15,000, which would be safe for the conditions specified, it would be criminal on his part to proceed with the work. Where the element of human life does not enter in such a large degree, as in this example, very often the engineer is inclined to overlook this aspect of his professional code of ethics.

ENGINEERING EDUCATION.

The subject of engineering education is one which has received a good deal of attention in the technical press. In a recent issue of the Engineering Magazine some reference was made to the present tendencies in the teaching of technical subjects and to the general problems arising in connection with engineering education.

Problems of engineering education are rapidly increasing in difficulty but the difficulties are perhaps not so apparent to the individual teacher presenting a single subject as to the faculty who must co-ordinate many subjects, or to the student who must within the period of the curriculum prepare himself for his special field of engineering work. Every one of these fields (civil, mechanical, electrical, mining, industrial) is rapidly expanding. New subjects are coming up; new specializations are evolving. To be prepared for whichever specialization may demand his life work, a student must make some preparation for all. The total weight of the

resultant work threatens to exceed the elastic limit of the time set for the course. The six-year course, supplanting the former four-year course, is already announced; and many able and earnest thinkers on the subject, looking back to the days when men began younger, and worked out their learning in parallel with their experience, fear serious disadvantages from the long residence in academic bounds and the late entry into the field.

Perhaps one difficulty comes from the conscientious thoroughness of the specialist teacher. He seeks the impossible purpose of turning out specialists. Perhaps another difficulty is the attempt to show too much practice. Practice cannot be efficiently reproduced in academic institutions whose function is rather to explain and inculcate principles—scientific data upon which practice is founded. Perhaps the greatest difficulty of all goes back to the preparatory schools. The university tries to build too intricate a structure upon too small a foundation, not always well laid, and, finding this insufficient, attempts to extend the foundation while construction is going on. The solution seems to lie in the direction of a much broader foundation and a much larger, more broadly conceived, but more elementary framed structure built upon it by the college course, leaving much of the arrangement and elaboration of the spaces between that framing to be completed after the student's more permanent intellectual leases have been let.

What we need most and increasingly is not more handicraftsmen, nor men skilled in more handicrafts, but more engineers of broad vision and wide general culture, capable of organizing and administering the work of the narrowly skilled, even if specially skilled, professional practitioner.

EDITORIAL COMMENT.

The article in this issue on the Zinn Building by Mr. T. Kennard Thomson will be of considerable interest to all engineers having to do with pneumatic caisson work. Mr. Thomson is one of the greatest living authorities on this question, and the methods used on this work are exceptional.

* * * *

A member of the Board of Control of Winnipeg objected recently to the cost of inspection. He said that the erection of city buildings was costing a great deal more than it should on account of the number of inspectors employed. This is a very good fault, indeed, if the system of inspection is efficient.

* * * *

It was announced last week by the Ontario Provincial Legislature that another million dollars is to be devoted to continue contributions toward the cost of good roads built by counties under the Highway Improvement Act. The previous million dollar grant for this purpose took ten years to dispose of. We venture to say that this million will last less than half that time.

* * * *

The recommendations of the Conservation Commission and the warnings of practical lumbermen will soon force the hands of the Dominion Government in connection with the present forestry policy. It is likely that steps will soon be taken to extend the present fire ranging system. While the protection question is important and demands immediate action, the reforestration of our burned lands and the planting of our waste places is of equal importance.

THE ANNUAL MEETING, ASSOCIATION OF ONTARIO LAND SURVEYORS, TORONTO, FEB. 27th, 28th, 29th.

The twentieth annual meeting of the Association of Ontario Land Surveyors will be held at Toronto, February 27th, 28th and 29th in the lecture-room of the Engineers' Club, 96 King Street West. As the members of the Association are honorary members of the Good Roads Convention, those coming by rail will be granted a reduction of fares upon presenting proper certificate. Blank forms for the certificates must be procured from the local railway agents when the single fare tickets to Toronto are purchased.

PROGRAMME.

Tuesday, 27th February.

Morning, 10 o'Clock.

Meeting of Council of Management.
Meeting of Standing and Special Committees.

Afternoon, 2 o'Clock.

Reading of Minutes of previous meeting.
Correspondence.
President's Address—J. F. Whitson.
Report of Council of Management.
Report of Secretary-treaurer (including Financial Statement).
Report of Board of Examiners.
Report of Committee on Legislation—G. B. Kirkpatrick, Chairman.
Report of Committee on Publication—Killaly Gamble, Chairman.
Report of Committee on Topographical Survey—Thos. Fawcett, Chairman.
Report of Committee on Exploration—H. T. Routly, Chairman.
Paper—"Rights of Way"—D. D. James.

Evening, 8 o'Clock.

Report of Committee on Repository and Biography—H. L. Esten, Chairman.
Report of Committee on Polar Research—Willis Chipman, Chairman.
Paper—"Canada's Mineral Wealth"—Dr. W. G. Miller.
Paper—"A Trip to Hudson Bay in 1900"—L. V. Rorke.

Wednesday, 28th February.

Morning, 10 o'Clock.

Report of Committee on Engineering—James Hutcheon, Chairman.
Paper—"Coal Tar for Roads"—James Hutcheon.
Paper—"Underground Surveys"—R. W. DeMorest.
Paper—"A Mountain Railway in Norway"—C. C. James, C.M.G.
Report of Committee on Drainage—George Ross, Chairman.
Paper—"Conservation in Canada"—James White.
Paper—"What Land Surveyors can do to Promote the Settlement of our Agricultural Lands in New Ontario"—J. F. Whitson.

Afternoon, 2 o'Clock.

Report of Committee on Land Surveying—J. McC Watson, Chairman.
Paper—"City Surveying"—T. B. Speight.

Paper—"Town Planning"—W. J. Moore.
Paper—"Re-marking of Governing Lines by the Government"—C. F. Aylesworth.
Report of Auditors—J. H. Burd and N. A. Burwash.

Evening, 7.30 o'Clock.

Dinner at McConkey's Restaurant.

Thursday, 29th February.

Morning, 10 o'Clock.

Report of Committee on Entertainment—A. T. Ward, Chairman.
Nomination of Officers:—President, Vice-President, Secretary-treasurer, two Members of Council, Auditors.
Unfinished Business—New Business—Adjournment.

ANNUAL MEETING ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION, TORONTO, FEBRUARY 26th, 27th, 28th.

PROGRAMME.

Monday, February 26th—Morning Session, 10 a.m.

Report of Executive; Appointment of Committees.
President's address—Major T. L. Kennedy, Dixie.
Address—W. R. Cummings, Cummings' Bridge.

Afternoon Session, 2 p.m.

Address—R. G. Geary, Mayor of Toronto.
Address—Andrew Broder, M.P., Morrisburg.
Address—Geo. S. Henry, Oriole.
Federal Aid for Highway Improvement—H. J. Bowman, Berlin.
County Road Construction, Ontario (illustrated)—W. A. McLean, Provincial Engineer of Highways.

Tuesday, February 27th—Morning Session, 10 a.m.

Address—Hon. J. O. Reaume, Minister of Public Works.
Address—W. G. Trethewey, Toronto.
State Highway Systems—Hon. Paul D. Sargent, Assistant-Director United States Office of Public Roads, Washingon, D.C.

Afternoon Session, 2 p.m.

Address—E. B. Osler, M.P., Toronto.
Address—A. M. Rankin, M.P.P., Collins' Bay.
Foreign Road Systems—L. A. Hamilton, Lorne Park.
Bridge Construction—James A. Bell, C.E., St. Thomas.

Wednesday, February 28th—Morning Session, 10 a.m.

In Reception Room, Parliament Buildings.
Report of Committee on Resolutions. Discussion.

11 o'clock.

Deputation to the Provincial Government. Speakers:—Mayor Hopewell, Ottawa; L. A. Hamilton, Lorne Park; E. M. Young, Picton; S. L. Squire, Waterford.

Afternoon Session, 2 p.m.

Address—James Armitage, Dunrobin P.O.
Township Roads—J. P. Griffin, Nelson; W. C. Bush, Port Dalhousie.
Election of officers.

GENERAL NOTES.

Precipitation exceeded the average in Central British Columbia and Alberta, also in the Highlands of Ontario, and very generally throughout Quebec and Eastern Nova Scotia; elsewhere in Canada it was deficient and to a pronounced extent in Saskatchewan and Manitoba. Although no definite depths of snow on the ground have been reported from British Columbia, it appears that there is a light covering near the Coast, and a considerable amount in the interior with excellent sleighing. In Keewatin the snow covering exceeds 20 inches, but in the Western Provinces, generally, the depth is from 2 to 8 inches. Twenty to thirty inches of snow covers the ground in the Highlands of Ontario and a lesser quantity, varying with the district, in other parts of the Province. In Quebec a depth of 13 inches at Montreal increases to 60 inches over the Gaspé Peninsula, while in the Maritime Provinces the snow is about 2 feet deep in Northern New Brunswick, and the depth decreases to about half inch in South-western Nova Scotia, although Cape Breton Island is covered with about 30 inches.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for January, 1912:—

	Depth in inches	Departure from the average of twenty years
Calgary, Alta	0.6	+0.14
Edmonton, Alta.	1.1	+0.39
Swift Current, Sask.	0.4	—0.26
Winnipeg, Man.	0.3	—0.67
Port Stanley, Ont.	3.3	—0.03
Toronto, Ont.	2.97	+0.16
Parry Sound, Ont.	7.3	+2.84
Ottawa, Ont.	3.0	+0.01
Kingston, Ont.	2.5	—0.37
Montreal, Que.	2.9	—0.85
Quebec, Que.	3.9	+0.70
Chatham, N.B.	3.1	—0.48
Halifax, N.S.	6.0	+0.15
Victoria, B.C.	4.1	—0 44
Kamloops, B.C.	1.2	+0.25

BUFFALO CITY WATER.

During the year 1911 the Department of Health of Buffalo, N.Y., had almost daily tests made of samples of water from the new and old tunnels by which the city draws its water supply from Lake Erie. Comparing the results, they found no decided difference from a bacterial standpoint in the quality of the water taken through the two tunnels, one of which takes the water from the lake proper and the other from the harbor. On days when weather conditions are such as to affect only the water of Lake Erie the tests are relatively the same. When the wind storms increase the amount of water at the end of the lake, raising the elevation in Buffalo's harbor, the tests show the water from the new tunnel to be superior to that from the old. During November colon bacilli were present in 1 cc. samples taken from the new tunnel seven times and eleven times in samples taken from the old tunnel. It is found to be a normal condition that there is a large amount of sedimented silt and organic matter in the water supply, and in view of this and the bacterial conditions some method of purifying is recommended.

THE PRINCIPLES OF SPECIFICATION AND AGREEMENT WRITING.

By C. R. Young, A.M. Can. Soc. C.E.

(Registered in accordance with the Copyright Act.)

Second Article.

THE COMPOSITION OF AN ENGINEERING CONTRACT.—Continued.

Relation of Specifications to Plans.

The great assistance which graphical representations furnish to the intellect leads to the making of plans or sketches as the initial step in the maturing of a constructional project. Errors and impracticable features are detected in this way much more readily than in written descriptions, and information which could be imparted only in paragraphs of writing is by graphical means conveyed at a glance. There are always certain facts, however, which may be expressed as well, and sometimes only, by means of writing, and, in order to avoid a great number of notes on the plans, these are set down in specifications. The specifications are thus complementary to the plans; they do not replace them, but contain information which it is not practicable to give on the plans. Generally, the specifications are prepared after the plans are complete, or when they are well under way, and, therefore, in case of conflict, it is reasonable to give the specifications precedence. Information which is last prepared is more likely to be correct than that prepared at an earlier date. Since errors discovered in preparing the specifications are often left uncorreted in the plans, it is desirable to not duplicate information on the plans and specifications.

Relation of Agreement to Specifications.

Specifications are intended to serve as an accurate guide in the actual physical construction, erection and finishing of the work, and sometimes also as a code of rules for the preparation of designs. In them should be set forth all the requirements of the Owner respecting the extent of the work, quality of the materials and workmanship, the tests to which the construction may be subjected, and analogous matters. To facilitate constructional operations, and to obviate disputes and delays, certain "General Clauses" are also inserted defining the authority and procedure of the Contractor and the engineer, or their representatives, on the work.

The agreement, on the other hand, records the mutual assent of the contracting parties to a proposal involving the performance of some act by one of the parties in return for some consideration from the other. The nature of this consideration and the general business relationship to be maintained between the parties during the progress of the work should be clearly stated. Whatever the form, extent or detailed construction of the agreement may be, it should, above all else, clearly and unequivocally disclose the mutual intention of the parties in signing the contract. This portion of the contract is thus of a more distinctively business or legal character than the specifications, although, as has already been pointed out, the latter are, quite as much as the agreement, a part of the contract.

Practice differs somewhat as to the relative length of the agreement and the specifications. Some engineers and architects place most of the so-called "General Clauses" or "Conditions of Contract" in the specifications, and thus keep the agreement very short. The advantages claimed for this method are that a standard form of agreement can thus be made to serve for a variety of contracts, and that a considerable number of changes may be made without affecting the agreement or the formal or "legal" part of the contract. On the other hand, many prefer to incorporate the "Conditions of Contract" in the agreement, or attach them to this part of the contract, leaving to the specifications only the description of the actual physical characteristics of the work. Legally, it is immaterial whether the general clauses are placed in the specifications or in the agreement, as a change in a clause affects the contract quite as much if the clause is in the specifications as if it were in the agreement. The writer is of the opinion that, on the whole, it is preferable to confine matters of the general business relations, privileges and responsibilities to the agreement, or to the **general** part of the contract—the part which the owner or any layman could most readily understand. The specification then becomes a brief technical document, containing in it all that most of those having to do with the actual physical construction of the work will require to consult.

Should any disagreement be discovered between the provisions of the specifications and the agreement, the latter is generally given precedence, unless the evident intention of the parties as disclosed in the contract as a whole would lead to a contrary interpretation. This arises from the fact that the drawing up of the agreement is the final step in the preparation of the contract, and because the contracting parties themselves are likely to inform themselves concerning the contents of this portion of the contract. The specifications are of necessity prepared by a technically-trained adviser of the Owner, and seldom, if ever, would the Owner or other lay party to the contract read them over. On the other hand, the agreement deals with matters familiar to all, and, since it contains the formal binding promise of the parties, they are likely to look it over carefully before affixing their signatures.

LEGAL ESSENTIALS OF A CONTRACT.

The Four Legal Essentials.

A contract is a promise, enforceable by law, to do, or to refrain from doing, some act. In order that it may be capable of enforcement it must conform to certain legal requirements based upon the English common law, and which have been elucidated and confirmed by a vast number of decisions in the courts of the English-speaking world. These essentials, without all of which no contract is binding, are, according to Wait, Johnson, and other authorities, as follows:—

1. The two contracting parties must be **competent** to enter into a contract.
2. The subject-matter of the contract must be **lawful.**
3. There must have been a **mutual assent** or agreement to the conditions named, or the two parties must have been of the same mind or intention regarding the subject-matter.
4. There must have been a valuable **consideration**; that is, something given in exchange for its legal equivalent.

The four essentials may be described briefly by the words, **Competency, Legality, Mutuality,** and **Consideration,** and under these headings the legal requirements of contracts will be discussed, with particular reference, of course, to those relating to engineering work.

Competency.—The right to enter into binding contracts is not universal, but is limited by law to those

persons, or groups of persons, who are physically and mentally capable of responsbility; and whose authority or powers in the matter under consideration are not specifically restricted by statute.

Among individuals, imbeciles, insane persons, convicts and confirmed inebriates are debarred from entering into binding contracts. Special care should be taken to avoid entering into an agreement with a man who is intoxicated, as he may, if the arrangement does not turn out to his satisfaction, be able to effect a release from it on the ground of irresponsibility. Persons under twenty-one years of age, and legally termed infants, may escape from the provisions of a contract if they so desire. Agents, as for example, engineers or architects, are not able to enter into contracts in the name of their principals concerning matters other than those over which they have been given authority. If the agent can be shown to have an interest in the affairs of the party which is contracting with his principal, the contract is voidable.

Groups of persons or organizations have certain contractual powers if they are incorporated. Thus, a private corporation may enter upon, and make contracts relating to any activity permitted by its charter, or any venture which, while not expressly mentioned in the charter, may be regarded as necessary for the complete carrying out of its specific purposes. On the other hand, congregations, societies, clubs, associations, or any unincorporated bodies cannot enter into binding contracts since they have no legal existence. In such cases it is necessary to have certain individuals personally pledge themselves for the amount involved if the other party to the contract is to effectually safeguard himself against loss.

Governments and governmental commissions may enter into contracts in much the same manner as individuals, but the powers of municipal corporations are restricted by law to those conferred upon them by Parliament or established by their own by-laws. It is of interest to contractors to note that, while suits may be brought against a municipal corporation, the Provincial and Dominion Governments may not be sued without their consent.

Legality.—In order that the subject-matter of a contract may be legal it must not transgress any statute, must not be opposed to the accepted principles of ordinary justice, or the common law, as it is called, nor opposed to public policy.

Violations of statutory law are involved in such contracts as the following: Contracts relating to the payment of a fee to an unlicensed practitioner (a surveyor, for example); contracts for undertakings beyond the legal powers of either of the contracting parties, as municipal work, the payment for which would require the statutory debt of the municipality to be exceeded; contracts let without the amount of advertising required by law; or, in some municipalities, contracts let to a bidder other than the lowest.

A contract is opposed to the common law, and is, therefore, illegal, which is based upon any fraudulent transaction or act. Changes in contracts made by one of the parties without the consent of the other, or by both without the conent of the sureties, render it void.

There are certain provisions commonly occurring in engineering contracts which, if enforced, would be prejudicial to the public welfare, and which render the contract illegal in so far as these clauses are concerned. For example, although parties are allowed to settle disputes by arbitration, either party may refuse to be bound by the award and carry his case to the courts. The law will not allow anyone to bargain away his right to be heard in a court of justice. Also, although agreements may be signed calling for the exaction of a penalty from one of the parties on failing to carry out his promise, this provision cannot be enforced unless the amount specified was intended to be a "genuine pre-estimate of damages" and not an arbitrary penalty. The right to inflict penalties is the prerogative of the law and not of private individuals or organizations.

Mutuality.—A contract to be binding on both parties must have been understood and agreed to by the two parties in the very same sense. The character of this understanding is judged from the written contract itself, and if the wording dicloses any essential difference of intention between the two parties the document is illegal. Where no such difference appears, it is to be presumed that the parties were of the same mind with respect to the subject-matter. Neither of the parties can in general upset the contract on the ground that the wording does not express his intention, for it was his duty to see that a wording was adopted which did express his understanding of the proposition. The exception to this is where one party has been misled or misinformed by the other, or by some one interested in the other, and has entered into the agreement with an erroneous conception of the actual facts. If the objectionable character of the contract is thus due to the fault or negligence of the complainant, he has no redress, but if it arises from the fault of some one interested in the other side he can have the contract set aside.

Consideration.—Unless the contract is under seal, there must be a valuable consideration, transferred from each party to the other. This does not require to be money, but may be anything whatever of value; for example, some work or act, or, indeed, the forbearance to do some act which the party transferring has a legal right to perform. The question of adequacy of consideration is, in general, not examined into by the courts, since it is presumed that the parties making the bargain should be the best judges of the worth of the consideration to them. If, however, the consideration is grossly inadequate or absurd, the courts will refuse to enforce the contract.

DESIRABLE CHARACTERISTICS OF AN ENGINEERING CONTRACT.

While a contract may possess all the legal essentials, it may, nevertheless, be very far from the ideal. Ability to successfully withstand attempts to upset it is not the only test of excellence. If, as a result of unfairness, ambiguity or other defects, disputes and litigation follow, it is undoubtedly a very badly-prepared contract. There are, therefore, many desirable characteritics of engineering contracts other than the formal legal requirements, and of these the following are among the most important:—

(1) Fairness.
(2) Completeness.
(3) Accuracy.
(4) Clearness.
(5) Brevity.
(6) Convenient arrangement.

Fairness.—The lack of fairness in an engineering contract may result in great hardship to a Contractor through no fault of his. Those who do not care to render themselves liable to unreasonable exactions will not bid on work under such auspices, and the Owner secures only a limited competition. If a reliable Contractor does bid, he covers himself by adding a considerable amount to offset the probable effect of the enforcement of the unfair

clauses in the contract. The reckless Contractor takes a gambler's chance in the hope that the untoward circumstance will not develop, and if they do, he does his best to extricate himself by influences of a more or less questionable character.

Unfairness in a contract may be exhibited in a great variety of ways. It is unfair, and generally unprofessional, for an engineer to require a Contractor to guarantee the engineer's plans. The engineer who takes such a position does not possess sufficient confidence in himself to be an engineer. Scarcely more defensible is the practice of the engineer disclaiming all responsibility for the quantities set down in the specifications or in the notice to bidders. In the short time generally allowed the Contractor for the preparation of his bid it is often impracticable for him to make explorations and calculations with anything like the thoroughness and accuracy which have presumably characterized the investigations of the engineer. If the Contractor were able to, and did, expend the time and money necessary for this preliminary work, the Owner would have to pay twice for such services. The engineer should accept the responsibility for his own quantities in so far as they are capable of accurate determination. Unfair, also, is the provision that the Contractor shall assume all risks of whatever kind. It is only right that he should be responsible for his own operations and for the acts and negligence of his own workmen, but to require him to assume responsibility for accidents arising from no fault of his own is unjust. Another instance of unfairness is the practice of specifying that the Owner will settle claims for damages and charge the amount up to the Contractor. The latter should be allowed to defend such actions himself in his own way, since the Owner cannot be expected to throw much energy into defending suits which, financially, are no concern of his.

Fairness to the Contractor, and at the same time the best interests of the Owner, require that the engineer should do all in his power to assist the Contractor to prepare an accurate, well-balanced bid. Anything new or unusual in construction, any detail differing in important particulars from those in similar work previously executed by the Contractor, or any changed clauses in an otherwise familiar specification, should be carefully pointed out to him before the submission of his tender. It never pays an Owner to award a contract at less than a fair price, for the Contractor will proceed to clear himself as best he may by inferior workmanship and by supplying poor materials.

Completeness.—The elimination of recklessness in bidding on the one hand, and inordinately high tenders on the other, necessitate completeness and definiteness throughout the contract. All information concerning the extent, general character and details of the work which would in any way affect his bid should be furnished the Contractor. A typical incomplete provision, calculated to provoke a dispute later on, would be the requirement that a surface is to be "plastered with cement mortar" without mention of the mixture or the thickness of the coat. Definite rules for the judging of the character of work and material should be laid down in the specifications. No clauses are more conducive to trouble and delays than those requiring the work to be "proper and sufficient," or "to the satisfaction of the engineer," or "as the engineer may direct." The bidder does not know just what the engineer may consider "proper and sufficient," and if his guess at the degree of severity likely to be maintained by the engineer in his rulings is not correct, the bid may be very wide of the mark. Provisions which are only half definite are likewise worse than valueless, since they lead to disagreements. For example, it is absurd to specify that "concrete shall not be dropped from a height," or "stones shall be as nearly cubical as possible." Such rules as are given should be absolutely definite and capable of but one interpretation.

In addition to the establishment of definite standards for judging materials and workmanship, completeness in the contract requires that all contingencies likely to arise in connection with the work and to materially affect it should be covered. It is not necessary that these probabilities should be the subject of lengthy provisions, but neither the Owner nor the Contractor should be continually confronted by matters which, because of undue brevity, were omitted in the contract. A few extra paragraphs in a specification may later on be the means of saving a great deal of time and a lawsuit as well.

Accuracy.—Unless a contract is accurate, or the limits of its accuracy is clearly defined, it is likely to entail trouble, and perhaps hardship, to one or other of the parties. Misleading quantities, as of earthwork, may cause a Contractor to submit a highly erroneous bid. The methods which would be suitable in removing a certain quantity of rock, and the price per cubic yard for which it could be handled, might be altogether inapplicable to half or twice that quantity. If the engineer cannot give exact quantities, the limit of variation at the prices named should be specified. If this limit were fixed for each kind of material at, say, 25 per cent., either way, and all work outside these limits were done on the "cost-plus-a-percentage" basis, the Contractor would know the worst at the outset, and neither party would be the subject of injustice. Not only errors in quantities, but errors in description of any kind are a serious obstacle to smoothness and despatch in the work, if, indeed, they do not precipitate litigation, or even void the contract.

Clearness.—Since the intention of the parties is, as expressed by Wait, "the pole star" in the interpretation of the contract, great care should be taken to express in writing precisely what was intended by both parties. Clearness is thus of paramount importance in the drawing up of contracts, and any device by which it is promoted is to be welcomed. While ambiguity may not result in voiding the contract, it may cause serious disputes, with attendant loss of time and money.

Brevity.—In general, the shorter the contract the better. The mastery of a document of a few pages is a much easier matter than the full comprehension of one of twice that length. Sometimes, also, the attempt to cover the work by mentioning everything in detail actually weakens the contract. Thus, where the joints between old and new concrete in an open-spandrel arch are required to be "at right angles to the dead load line of pressures in the ribs and at right angles to beams and slabs at their middle points," the provision does not apply to joints in spandrel posts. If the provision were that the joints were to be "at right angles to the line of resultant axial pressure and at the middle points of beams and slabs," it would be briefer and of more general application. However, contracts do not generally err on the side of undue length, and the plea for brevity cannot be regarded as of especial importance.

Convenient Arrangement.—The orderly statement of the facts forming the subject-matter of a contract is greatly to be desired. Not only does it save the time of those who have to consult the completed document, but it diminishes the probability of anything being overlooked in its preparation and interpretation.

POWER PLANT OF McGILL UNIVERSITY.

A paper by Mr. R. J. Durley on "The Central Heating and Power Plant of McGill University, Montreal," read before the Institution of Civil Engineers, described the arrangement and equipment of a central heating plant, combined with an electric light and power station, which was designed to serve the various buildings of the University.

Although only of moderate size, the installation, he said, was of interest on account of the somewhat severe climatic conditions and the unusual nature of the service. The climatic conditions were shown in a table which gave the maximum and minimum temperatures for the winter of 1908-9. These were, in deg. F.:—October, 1908, 74.6, 29.3; November, 56.3, 17.4; December, 52.1, —9.5; January, 1909, 42.3, —17.2; February, 41.2, —12.4; March, 41.8, 3.6; April, 67.0, 19.4, and May, 73.6, 33.5. Attention was directed to the fact that the economic possibilities of such a station depended very largely on the relation between the demand for heat and that for electric current.

Up to 1908 the University buildings were heated individually by their own steam or hot water equipment, and current was taken from the local electric supply company. The coal used for the heating service was necessarily of an expensive kind, and the cost of current was rather high, Economy and improvement in service, therefore, were sought by utilizing cheaper coal in a central boiler plant and by heating the various buildings from one source, employing for this purpose as far as possible the exhause steam from electric generating sets. The buildings which would ultimately be served had a total volume of about 7,570,000 cu. ft.; they contained 81,000 sq. ft. of direct-radiation heating surface, needed 185,000 cu. ft. of warmed air a minute for ventilation, and required a maximum of about 475 kw. for light and power. The greatest demand for steam for heating and ventilation for all the buildings in cold weather would be about 30,000 lb. an hour. The station as at present working supplied current to 11 buildings and heat to five. The heating service would be extended to all the buildings as opportunity served.

A brief discussion of the systems of heating and ventilation in general use in Canada for large buildings and a description of the nature of the demand for steam and current for the University purposes was followed by notes regarding some of the problems arising in the design and construction of underground piping systems for steam and hot water. The McGill power-house itself was not of an unusual type, its equipment including four water-tube boilers, three steam electric generating sets, the necessary heaters and auxiliary machinery, and the ordinary apparatus for the switchboard and electric accessories. The heat distribution to the buildings being largely by means of forced-circulation hot water as well as by steam, the heaters and circulating pumps were installed in the engine-room, and were at present capable of supplying hot water to 60,000 sq. ft. of direct-radiation heating surface. Means were provided for obtaining a record of the heat delivered to the heating surface. Means were provided for obtaining a record of the heat delivered to the heating systems of the various buildings.

The electric distribution was effected by underground cables throughout, the cables as well as the heat distributing pipes being carried partly in tunnel and partly in conduit. Secondary heaters had been installed in two of the buildings in order to avoid the expense of renewing the existing heating pipes and radiators. The paper concluded with a description of the methods of operation adopted and the systems of temperature regulation employed, together with some notes as to working costs.

LIGNITE IN SASKATCHEWAN.

Mr. Geo. Bell, M.P.P., of Estevan, Sask., has introduced a bill before the Provincial House calling for an enquiry into the immense deposits of lignite throughout the province. In introducing the bill Mr. Bell said there were enormous deposits of coal in the province; the quantity was practically unlimited. The coal was of peculiar character. The quality is lignite, and not of the best. It contains the smallest percentage of fixed carbon, and is therefore small in heat value. His object in bringing up the resolution was to secure full information regarding the feasibility of using the coal for power or other purposes. Because of the great quantity of moisture in the coal it was as yet of very little use in its raw state. By pulverizing the coal and allowing the entrance of considerable air, the coal was found fairly satisfactory for furnace use. It is possible that some further development along that line might be effected by the inquiry proposed. It was found in the United States that lignite coal could be used successfully for gas producer purposes. Similar experiments with more or less satisfactory results had been made in Germany and England. The most interesting experiments were made recently by the mines branch of the Univserity of North Dakota. The coal was very similar, containing practically one-third moisture and one-third carbon. Experiments made with the raw coal had proved to be a failure, and it was impossible to make briquettes. The North Dakota experiments, however, used the coal after being roasted in a retort. The residue was mixed with a satisfactory binder, and a briquette formed which would withstand exposure to the elements, and which possessed a very high heat value. They burned without disintegrating, and were entirely consumed. The ashes were found to contain less unconsumed carbon than anthracite ashes. The result was that the briquettes were found to be equal to twelve-thirteenths of a similar quantity of anthracite coal. The same fuel was believed to be very satisfactory for producing gas. No figures were given, however, as to the probable cost of producing power from this source, and as Saskatchewan possessed no figures as to the cost of transmission the inquiry should provide a great deal of useful information. The possibility of securing from the coal deposits a high-class domestic fuel opened up a very important avenue of development.

This lignite coal will not stand transportation. It will not hold together when exposed to the air. This fact results in the coal mines being idle for about half the year and the consequent tying up of that amount of capital for a greater part of the year. The freight on the coal is just as high as on better classes of fuel, and the result is a very serious handicap to the coal mining industry.

There is a possibility of finding a cheap source of power, for each ton of coal produces 11,000 feet of gas.

HUDSON BAY WORK.

The Dominion Government has decided to send engineers to examine Port Nelson and Fort Churchill, on Hudson Bay, and report as to which will make the most suitable terminal for the line from Le Pas. The engineers will leave for Winnipeg in the course of a few days, and will there take dog train for Hudson Bay. The Government hopes to have a report early in the year, so that further contracts can be let.

MUNICIPAL WATER PURIFICATION PLANT, GRAND RAPIDS, MICH.*

By J. W. Armstrong, C.E.

The filtration plant now being constructed for the City of Grand Rapids is the outgrowth of a project which was first seriously undertaken some twelve years ago. Little real progress was made, however, until 1909, when Messrs. Hering & Fuller were employed to report upon the best available method of securing a new water supply for the city. They advised in February, 1910, the construction of a mechanical filter plant having a capacity of twenty million gallons daily. for purifying the water of the Grand River, and that a complete water-softening plant, together with all the necessary appurtenances, including reaction and coagulating reservoirs, be built for preparing the water for filtration. A clear-water reservoir of three million gallons capacity was also recommended.

The water of the Grand River is a moderately hard water for the central West, and a very hard water, as viewed from the standpoint of waters of the Atlantic seaboard. It is about twice as hard as the water of Lake Michigan. It is frequently uninviting in appearance, partly due to the color or vegetable stain which it contains, and this is augmented at times by soil wash, which produces more or less turbidity or mud in the water as supplied to the consumers. As regards the bacterial analysis, the water, while polluted to an extent that makes it undesirable and at times unsafe for drinking purposes in its raw condition, is certainly not grossly polluted, and can be made entirely satisfactory in quality after being treated in a thoroughly well built and well operated filtration plant.

A brief description of the course taken by the water in its passage through the plant may prove helpful in understanding what follows:

The water passes from the intake into a concrete conduit to the pumping station, where it is picked up by a centrifugal pump and forced into an equalizing chamber in the head house. From here at times of high turbidity in the river, it enters into the grit chamber, where sand and heavy suspended matter is settled out. After passing through the grit chamber it enters a mixing chamber, where the chemicals are applied, and the water is kept in rapid motion until the proper reactions have taken place, when it is admitted into the coagulation reservoirs, where the water is prepared for the filters and most of the impurities are precipitated to the bottom. After leaving the coagulating reservoirs the water passes through the sand filters, and from there into the clear-water reservoir, from which it is finally led through a concrete conduit to the high-lift pumping station.

The pumping station is located centrally and adjacent to the filter gallery. The centrifugal pumps, which are of the single-suction vertical-shaft type, are located in a pit. The pumps are placed with their centres below extreme low water level in the river, which insures their being always primed. There are three raw-water pumps, each capable of lifting eight million gallons a day against a head of thirty feet. There are two smaller raw-water pumps, each of a capacity of four million gallons a day against the same head. On a tee in the suction line of one of these pumps a valve is attached which opens into the room and is operated by an extension stem from the floor above. This enables the raw-water pump to be used as a sump pump should the pit become flooded. The raw-water pumps are designed to be operated automatically, starting when the water falls below a certain level in the epualizing reservoir and stopping when it reaches a certain predetermined elevation. They are also capable of being operated by hand. All the raw water is discharged into a 36-inch force main laid under the floor of the filter gallery, in which is placed a 36-inch Venturi meter with an 18-inch throat. This arrangement effected quite a saving in the length of piping, but prevented an ideal arrangement of the pipe gallery.

The two wash water pumps each have a capacity of 1,000 gallons per minute against a maximum head of 52 feet. These pumps discharge their water into the wash water main in the centre of the filter gallery. They are designed to stop automatically when the water reaches a certain elevation in the wash water tower, but they require to be started by hand. The reason for this method of operation is to enable the exact amount of water required for each filter washing to be accurately determined, which could not be done if water were to be pumped into the tank at the same time it was being withdrawn. The motors operating the pumps are located upon the ground floor, and they will be run by alternating current of 440 volts, transmitted through underground cables from the high-lift pumping station.

The water is pumped into an equalizing chamber in the head house, which acts as a centre of distribution, and from there it ordinarily passes directly into the grit chamber, through a 42-inch by 42-inch sluice gate. During flood times the river water contains a great deal of sediment that is extremely desirable to get rid of before applying the chemicals. Most of the heavier suspended articles will be deposited by plain subsidence in traversing the grit chamber, which is 152 feet 8 inches long and 21 feet wide, and will hold about 367,000 gallons.

The mixing chamber is adjacent to the grit chamber and is 44 feet wide by 160 feet long and holds approximately 732,000 gallons. Wooden baffles of the "around-the-end" type are spaced three feet apart for the full length of this chamber. This type of baffle permits the operation of the plant with varying heads of water and offers reasonably good facilities for cleaning and inspection. Water can be drawn from the mixing chamber at four different points through the sluice gates. As the condition of the water changes, the time for chemical reaction can be shortened and lengthened. Should the water be drawn from the gate most remote from the entrance it will have to travel four times as far as it would if drawn out at the first gate and the time for chemical reaction would be correspondingly lengthened. The grit chamber and mixing chamber were designed with flat top and bottom, the bottom being reinforced in the style of a mushroom floor system for the purpose of resisting upward pressure.

There are two coagulating basins. The smaller of the two basins is 88 feet 6 inches by 118 feet 9 inches, and holds 1,134,000 gallons; the larger basin is 118 feet 6 inches by 118 feet 9 inches, and holds 1,452,000 gallons. The basins can be operated singly in parallel or in series. They are covered with groined arches supported by columns. It has been noticed in reservoirs with a few baffles that there is a tendency for water to short-circuit and for the floe to settle out unevenly in different parts of the reservoir. In order to overcome this difficulty and to maintain a more even distribution of the floe, the baffles in this basin are much closer than has been the case heretofore, being fifteen feet on centres. The water is withdrawn from the reservoirs over a skimming weir made of thin stop-planks. The object in using the thin planks is to interpose a weak point that would give way should the water suddenly be withdrawn on the opposite side, and thus save the concrete work, which is not designed to withstand a full water load. They offer the further advantage of enabling the water to be taken from various depths below the surface.

* From a paper before the American Society of Municipal Improvements.

A feature of this plant which has saved considerable piping and a number of valves, is the double conduit. The water from the mixing reservoir enters the lower compartment of this passage through one of four sluice gates and from there enters the coagulating basins through a sluice gate. After passing through the coagulating basins the water is taken into the upper compartment and conveyed on to the filters. By-passes consisting of sluice gates opening either into the upper or lower passage are so placed that the raw water may be cut out of the grit chamber and passed directly into the mixing chamber or directly into the coagulating basin, or all of the basins can be by-passed and raw water turned directly into the conduit leading on to the filters. Water that has been passed through the mixing chamber can also be admitted to the upper passage and taken directly to the filters, by-passing the coagulating basins. It is thus seen that an unusual degree of flexibility can be obtained in the operating of the plant.

There are ten filters with a normal rating of two million gallons each, five of which are on each side of an eighteen-foot pipe gallery. The filters are built of reinforced concrete, and are supported directly upon the groined arches which form the roof of the clear-water basin. They are 25 feet by 38 feet outside measurement. Each filter is divided into halves by a centre gutter, and there are twelve concrete lateral gutters, sixteen inches wide. In washing, all water is carried off through the lateral gutters, none of it being allowed to flow directly into the centre gutter. Each filter has about 738 square feet of sand area, aggregating 7,344 square feet for the ten filters.

The strainer system is constructed of concrete ridge blocks spaced in rows twelve inches apart across the filter. The end blocks are nine inches wide at the base and have perpendicular sides for a height of five inches, at which height a seat is left for the support of the perforated brass strainer plates, which extend in rows entirely across the filter. For a height of eight inches above the strainer plates the blocks are in the form of a truncated wedge. The space between the ridges is filled with four different sizes of gravel, held in place by a brass wire screen. The water, after passing through the filter sand and gravel, enters the water passage between the ridge blocks, from which it passes into the centre collector and from there into the pipe system underneath the filters. In washing the filters the direction of flow is reversed, filtered water being passed rapidly through in the opposite direction.

Filter rate controllers of the Earl type are to be installed. These controllers are constructed in such a way as to respond to the pumps. If the water level in the clear-water basin is lowered, the rate of filtration will increase until a maximum is reached when all filters will discharge at the maximum rate for which they are set until such time as the water again rises, when the filters will gradually slow down until the clear-water basin is full, and then shut down entirely.

As it would require very large pumps to supply the wash water at the high rate at which it is applied, it was decided to employ an elevated tank for washing the filters, which could be filled by means of small pumps during the interim between washes. This structure is built over the clear-water reservoir and the columns supporting it are carried to solid rock. The tank, supporting beams and columns, are built of reinforced concrete; the exterior is of brick to match the other buildings.

The main body of the head house is 46 feet by 60 feet 3 inches outside, which with the addition of a projection for the tower gives a total floor space of about 3,000 square feet. The building has a basement, ground floor, mixing floor and tower. The basement is divided into two parts, one of which receives the water from the pumps and acts as an equalizing chamber and distributing point for the raw water. The other compartment contains the steam boiler and coal storage bins, together with the elevating and crushing machinery, and a vacuum cleaner. Upon the ground floor are located the various operating stands for controlling the valves and sluice gates and all the chemical controllers. The operating floor contains all the apparatus for mixing and storing chemical solutions. The tower contains the bins for the storage of chemicals and the apparatus necessary for handling and conveying the material. The building is constructed of reinforced concrete with the exception of the outer walls, which are of brick.

From the solution tanks the chemicals will flow by gravity to the controllers which are located on the floor beneath, and after passing through the controllers will flow by gravity to the point of application to the water. The operator is enabled to vary the time allowed for chemical reaction to suit the changing condition of the water. For each of the solutions duplicate controllers of the Earl type are provided. They are all operated in conjunction with a Venturi meter and a master controller which so regulates the depth of solution that the head above the discharging orifice varies in direct proportion to the amount of water passing into the reservoirs through the meter. After the orifice has been properly set the action of the controller is entirely automatic, and however much the quantity of water passing through the system may fluctuate, chemicals in the correct proportion will be supplied. An additional alum controller is provided for furnishing the amount that may become necessary for corrective treatment. Each of the chemical solution tanks is provided with a recording gauge, operated by a glass float. The recording device is to be enclosed in a neat glass case supported on a bracket on the outside of the tank.

For agitating the chemical solutions each of the tanks is equipped with a two-bladed propeller mounted in a funnel-shaped casing, with its bottom edge supported three inches above the floor of the tank. The propeller will be operated by an electric motor hung from the under side of the tank. The agitation is violent and keeps all inert or undissolved matter thoroughly in suspension until it is drawn off into the piping system. The agitation is particularly good in the corners of square tanks.

The work of constructing the filtration plant was divided into four separate contracts, the first of which was for building the clear-water conduit, intake, and drain. It involved the construction of about 2,900 lineal feet of conduit and was awarded to J. P. Rusche in July, 1910, for $51,518.44. Contract No. 2, for the furnishing and installing of all pumping machinery was awarded to the Fort Wayne Electric Company, who coupled to their motors pumps made by the Buffalo Steam Pump Company, the contract price being $12,425. Contract No. 3 was for the various basins and substructures of the bulidings. It included practically all the grading and the bulk of the concrete work. This contract was awarded to Prang & Co. for $123,842. The fourth contract was for the construction of buildings, wash-water tower, filters, piping, and all the special devices employed in the plant. The Roberts Filter Manufacturing Company, of Philadelphia, were awarded this contract for the sum of $159,882.

All plans for the construction of this plant were prepared by the firm of Hering & Fuller in their New York office, and since the dissolution of the firm. George W. Fuller has been employed as consulting engineer on the construction of the works. The construction has been done under the general supervision of Samuel A. Freshney, secretary and general manager of the Board of Public Works of Grand Rapids, Mr. R. E. Harrison being the resident engineer in direct charge of the work.

Metallurgical Comment

T. R. LOUDON, B.A.Sc.

Correspondence and Discussion Invited

ZINC SMELTING IN ELECTRIC FURNACES.

During the last five or six years electric zinc smelting, inaugurated under the De Laval patents, has been conducted at Trollhattan, in Sweden, and at Sarpsborg, in Norway. Some progress in ore smelting was made, and during 1911 the works were studied by F. W. Harbord, in behalf of the Norse Power & Smelting Syndicate, organized to take them over and enlarge them. The following is a summary of Mr. Harbord's report:—

The Trollhattan works has a furnace building about 300 x 52 ft., equipped with 11 smelting furnaces of the new resistance type, six on one side of the building and five on the other, two refining furnaces and several of the old type of arc furnaces, which at present are not working and are to be replaced by the new resistance type. The furnaces are arranged in two rows, one on each side of the building, the condenser sides of the furnace facing each other.

The furnaces of the resistance type are of 350 horsepower each, having one large vertical electrode passing through the roof, the other electrode being a carbon block bedded in the bottom of the furnace. The ore is charged through the roof. In the more recently erected furnaces the charge opening is on one side of the electrode only. A furnace is being erected with a continuous side-feed, which it is anticipated will give improved results. Two electrodes are fastened together to form the vertical electrode, which then measures 0.218 sq.m. in cross-section and 3 m. in length, its weight being 680 kg. The capacity of each furnace is approximately three metric tons, and the actual smelting is about 2.8 tons of ore per 24 hours.

Current is supplied to the works by a high-tension three-phase system of 9,640 volts and is transformed by single-phase transformers to low-tension single-phase current, the nominal ratio of transformation being 10,000:110. The transformers are of the open type, air-cooled by forced draft from two fans, the average loss of energy across the transformers being 2.5 per cent. of the energy at the furnace. The transformers are situated in a tunnel under the furnace room, each transformer being placed as near as possible and immediately below the furnace to which it is connected.

The smelting process consists in charging the ore, with suitable additions of flux and reducing material (such as anthracite or coke) into the furnace, where most of the zinc and some of the lead are volatilized and condensed, partly as metal and partly as blue powder and oxide, containing about 54 per cent. of zinc and 20 per cent. of lead. This powder is then mixed with fresh ore and recharged, when a much larger percentage of the metal volatilized is recovered as metal. The first operation of smelting ore alone may be regarded mainly as a concentrating process for the production of a rich oxide, which is reduced to the metallic state by subsequent treatment.

The other portion of the lead, carrying a considerable proportion of the silver, is mainly reduced to metal in the smelting hearth and is tapped out with the slag. Some of the lead, zinc and silver passes into the matte and some into the slag.

In the test conducted by Mr. Harbord and assistants, the following were the charges first used, four furnaces working on ore-powder mixture and three furnaces on ore mixture: Ore powder mixture; Broken Hill slime (roasted), 100 kg.; powder, 200 kg.; coke dust, 25 kg.; lime, 5 kg. Ore mixture: Broken Hill slime, 300 kg.; calamine, 10 kg.; coke, 75 kg. At the end of the second day the ore furnaces were making sufficient powder to supply the powder furnaces (powder had previously been taken from the works stock in order to start the test) and from this time until the end of the run no further powder was taken from stock. The furnaces were tapped every four hours for crude zinc and powder, and the slag, matte and lead were tapped about every eight hours. During the run a good deal of trouble was experienced from break-outs of lead near the bottom of the furnace, due evidently to the furnace bottom becoming saturated with lead.

During the early part of the run the slags were far from clean, containing large quantities of zinc and lead, chiefly due to imperfect separation of the matte, which in turn was due to imperfect mixing of the charge and to the slags being too basic, owing to improper proportions of flux and reducing agent. Later on the slags improved considerably, although not infrequently two furnaces working side by side on the same mixture would give totally different slags, showing clearly that this was due to some outside cause, like irregular mixing.

Another serious trouble was the removal of electrodes, which caused very considerable delay, due to a great extent to the defective mechanical appliances for removing and replacing the parts. The average time for changing an electrode was 150 min., whereas it should easily be done in 30 min. with proper appliances. Although there were various minor troubles, there was no serious stoppage caused by failure of the furnaces.

During 27.58 days of the experimental run, the furnaces smelted 518 metric tons of Broken Hill slime (roasted)) 19 tons of calamine and 22.5 tons of blue powder (from stock); and produced 160.8 tons of crude zinc and 36 tons of powder. The powder produced by the different furnaces was recharged with fresh ore, a portion each time being reduced to metal, and the final result at the end of the run was 13.4 tons more powder on hand than at the beginning. The crude metal obtained from this smelting averaged about 79 per cent. zinc, 20 per cent. lead and 0.6 per cent. iron. This was afterward refined, with a production of 112.4 tons of spelter (assaying 99.9 per cent. zinc) and 24.7 tons of lead. The lead tapped with the slag was remelted, in order to remove the slag. This yielded 41 tons of marketable bullion, containing 141 oz. of silver per ton. In addition to this there was obtained 17 tons of leak-lead, assaying 27 oz. of silver per ton. There were also nearly nine tons of skimmings containing zinc, lead and silver. The total input of metals was 204.04 tons of zinc, 128.35 tons of lead and 15,750 oz. of silver. The extraction in the form of metals was 130.46 tons of zinc, 94.94 tons of lead and 7,230 oz. of silver, showing a yield of 64 per cent., 73.99 per cent. and 45.9 per cent. respectively. If the metals in the powder be included the percentage yields are 73.4 zinc., 79.3 lead and 49.5 silver. Mr. Harbord considered that the losses of lead and silver were unduly large because of the retention of some of those metals in the masonry of the furnaces.

Mr. Harbord was of the opinion that the method of charging through the roof leaves much to be desired and anticipates much better results from side charging. Very considerable quantities of valuable fine dust were lost, owing to inadequate arrangements for its collection. A modern bag house, or its equivalent, would lead to an increased

recovery of dust. He says furthermore: "The weak point of the process is the large amount of metallic powder produced in proportion to the metals. The recovery of a large percentage of metals as metals is admittedly a very difficult problem, but that the present practice can be very greatly improved upon, I have not the least doubt, leading to decreased consumption of energy and reduction of labor cost.

One detail, which is a great improvement on the early practice, is the better separation of the crude zinc from the powder by a mechanical stirrer, which was only tried just before we commenced out investigation."

At Trollhattan practically the whole of the crude zinc made during the experimental run was afterward refined. Out of 111,794 kg. of crude zinc there was obtained 78,136 kg. of fine zinc, 17,179 kg. of lead and 11,209 kg. of powder (corresponding to 10,088 kg. of metals). Consequently, there was a loss (unaccounted for) of 5.7 per cent. This loss was distinctly higher than the average, as shown by the records of the works over a considerable period, and probably is explained by the new brick work continuing to absorb some of the metal. In the refining of commercial spelter at Sarpsborg the average practice has been as follows: Fine zinc, 83.9 per cent.; powder 9.8 per cent. (corresponding to 8.8 per cent. metals); residues (lead, etc.), 2.20 per cent.; charge in furnaces, 1.1 per cent.; impregnation in brickwork of furnaces and condensers, 0.5 per cent.; unaccounted for, 3.5 per cent.; total, 100 per cent.

Mr. Harbord also conducted an experimental run at Sarpsborg. The works at that place have three smelting furnaces of the old arc type and four refiners. During 20 days he smelted 133 metric tons of Broken Hill roasted slimes and three tons of calamine. For the first day, to enable two out of the three furnaces to be put on powder mixture about 3.5 tons of powder were borrowed from the works stock, but after the first 24 hours sufficient powder to supply two furnaces was made, the third being kept on ore charge alone until within about 36 hours of the finish of the run, when powder was charged with the ore to use up some of the excess stock made during the run. The furnaces worked very well and gave no serious trouble, but the slags were far too basic and contained very large percentages of both zinc and lead, and at no time during the trial run was any matte obtained separate from the slag, the latter being really a mixture of slag and matte. During the run 43 tons of crude zinc and 12 tons of tap lead, containing 191 oz. silver per ton, were obtained. No leakage lead from the furnace bottoms was obtained. The crude spelter contained 74.74 per cent. zinc, 24.57 per cent. lead, and 0.7 per cent. iron.

The consumption of electric current in the experimental run at Trollhattan averaged 2,078 kilowatt-hours per ton of ore smelted. The cost of power at Trollhattan is at present 30s. 3d. per horse-power-year, or 41s. 3d. per kilowatt-year.

The arc furnace, so far as the process of actual smelting is concerned, was found to give just as good results as the resistance furnace, but the consumption of energy was over 70 per cent. more. The method of hand feeding the electrode was slow and unreliable, especially as regards keeping the arc in the centre of the furnaces. The consumption of electrodes also was materially higher than in the case of the resistance furnaces. At Trollhattan the average consumption of electrodes was 31.51 kg. per 1,000 kg. of ore smelted; at Sarpsborg it was 40.57 kg. per ton of ore. If it be decided to continue smelting at Sarpsborg, the old type of arc furnace will have to be replaced by resistance furnaces.

THREE-PHASE CURRENT FOR MERCHANT MILL DRIVING.

C. A. Ablett.

The roughing rolls of a merchant mill should be run at the highest speed at which it is found practicable for the men to catch the comparatively short billet, and as in most cases about the same size of billet is being rolled the speed should remain constant. The finishing rolls, on the contrary, should be capable of running at a large number of different speeds according to the shape and weight of section being rolled.

Light sections which cool rapidly must be rolled at a high speed so as to finish them while hot, but with heavier sections the rate of cooling is slower, so that there is not the necessity for rolling at a high speed, while there is the advantage that better material is obtained if the speed of rolling is lower.

The slowest speed is required for "hand rounds" where the roller has to guide a bar of oval section with his tongs through a round hole so that the biggest diameter of the oval stands upright, and unless the speed is low the roller cannot follow up the bar.

If the roughing and finishing mills are coupled together and driven by one motor, it will not be possible to run at a sufficiently high speed for the light sections on account of

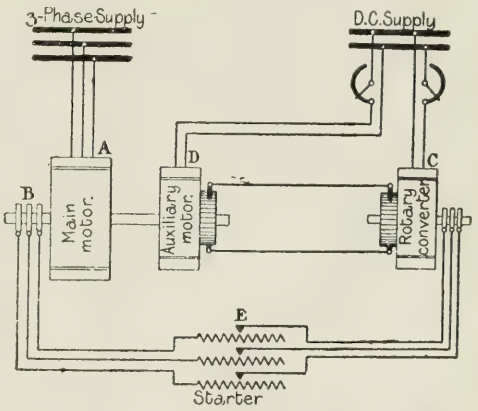


Fig. 1.—Diagram of Connections of High-Efficiency, Variable-Speed, Three-Phase Rolling Mill Motor Set.

the roughing mill, so that the roughing mill will restrict the output of light sections, while on the other hand, when rolling "hand rounds" the low speed of the finishing mill will require that the roughing mill also go at a low speed and the output be also restricted. With such a mill the proper outputs can only be obtained at the medium speeds. The ideal drive, therefore, is to provide a constant-speed motor for the roughing mill and a separate variable-speed motor for the finishing mill, and when this is done the roughing mill is usually placed in tandem with the finishing mill.

Where the power available is direct current, this arrangement presents no difficulty, but where three-phase current must be used, the means of providing a variable-speed drive for the finishing mill needs some consideration.

A still more economical arrangement for obtaining variable speed has been adopted for three merchant mills in this country. (Fig. 1.) This consists of employing a three-phase motor direct coupled to a direct-current motor for driv-

* Abstracted from a paper read before The Institution of Electrical Engineers.

ing the mill. A rotary converter is connected to the rotor circuit of the three-phase motor, so that when the set is run at reduced speed the power which would otherwise be wasted in resistances in the rotor circuit is converted by the rotary converter from three-phase to direct-current, and then used usefully to supply the direct current motor.

Comparing this scheme with that of converting all the three-phase power to direct current and installing a direct-current rolling mill motor, it should be pointed out that in this latter scheme the rotary converter and the direct-current motor do not have to deal with the entire power, but with a power proportional to the amount that the main three-phase motor is running below synchronous speed. The conversion losses are therefore reckoned on a fraction of the power, and not of the entire power, so that the arrangement is much more efficient. Further, the rotary converter and the direct-current motor are proportioned for a fraction of the power instead of the whole power, so that they can be small machines. The arrangement, therefore, is cheaper in capital cost. With this arrangement, the direct-current motor is provided with a compound winding to act as a continuous-slip regulator, and the combination behaves like an ordinary compound-wound direct-current motor, the speed being varied by altering the resistance of the shunt field circuit of the direct-current motor, while with the exception of that variation in speed necessary to enable the flywheel to give up and regain part of its stored energy, the mill motor set runs at the required speed and does not give trouble by attempting to increase in speed up to the maximum speed between the passes.

Generally speaking, where there is a choice between direct current or three-phase for driving a mill for which variable speed is desirable and there is little or no difference in the cost of current, the adoption of direct current will be found the most economical.

Friction Losses.—Particular care should be taken to reduce as much as possible the friction losses, or other such losses which have a constant steady value independent of the power which the rolling mill may be giving, because, generally speaking, the power taken by a motor driving a rolling mill varies between wide limits so that the average power taken is very much less than the rated output of the motor, and any losses such as those due to friction, which go on continuously, very considerably increase the number of units of electricity used in a given time.

This is a point which is very liable to be overlooked, because such losses are usually stated as a percentage of the rated output, as is often the case, a friction loss which may average power of a rolling mill motor is one-third of its rated output. as is often the case, a friction loss which may be only 10 per cent. of the rated output will increase the total units consumed in a given time by 30 per cent. Such friction losses may be caused by the friction in the flywheel bearings, or by the windage of the flywheel itself or in the drive used to transmit the power of the motor to the mill in those cases where the mill motor is not direct coupled.

To take a practical example, the case of some tinplate mills may be considered which require a 450 horse-power motor, where the power varies between very considerable limits, and where there is a choice between installing a high-speed motor driving the mills through a rope drive, or installing a slow-speed motor direct coupled to the mill.

It may be assumed that the loss in the rope drive is 10 per cent. of the full-load power of the motor, that the efficiency of the slow-speed motor is 2 per cent. less than that of a high-speed motor, and that the actual power consumption required by the mill apart from the drive is 15,000 units per week. If a slow-speed motor be installed, 2 per cent. must be added to the 15,000 units on account of the low efficiency, so that the units consumed in the week will be 15,300. If the 450-b.h.p. motor ran steadily at its full power, making due allowance for 5 per cent. loss in slip resistance, etc., the steady input would be 385 kw.; therefore, if the motor ran steadily at its full power for a week of 120 working hours it would consume 45,000 units. Ten per cent. of this, or 4,500 units, are wasted in the rope drive, so that if the high speed motor with the rope drive be installed, the total units consumed per week will be 19,500, or 4,200 more than if a slow-speed motor be used. Supposing that the cost of power is 0.5d. per unit, the extra 4,200 units used per week will cost £8 15s., or £437 10s. per annum. This saving would justify a very considerable extra capital expenditure on a slow-speed motor.

The question of electrical driving is seldom raised without comparisons being made between the cost of driving rolling mills by steam or by electricity, but it is outside the scope of this Paper to revive this well-worn subject. Various economies can be effected by the electrical driving when properly applied, but one of the principal economies is that of the cost of power. The electrical drive often enables cheap power to be used when it could not be transmitted or applied in any other way, and also in many cases it affords a means of enabling power to be generated cheaply.

Where cheap power is available it must be applied as economically as possible, and it will be seen from what has been said in the foregoing that considerable care must be exercised in applying a motor and flywheel to a rolling mill in order to ensure that the power is utilized as cheaply as possible if it is desired to obtain economy in working.

THE PROPOSED MACKENZIE AND MANN STEEL PLANT.

The newspapers of late have published material descriptive, to a more or less extent, of the proposed steel works for Port Arthur, Ont.

It is stated that the Mackenzie and Mann interests are going to spend approximately $8,000,000 in establishing new industries at Port Arthur, $5,000,000 of which are for the steel works.

The Port Arthur Board of Trade, in their literature of late, have drawn attention to the fact that pyrites of iron and copper, also other iron ores, were to be found in quantity in the vicinity of Port Arthur.

The financial interests supporting this scheme, according to report, will commence operations in the spring of 1912, upon the erecting of numerous factories on the water front. They intend to establish a steel plant, comprising blast furnaces for the smelting of iron ore, rolling mills, merchant mills, steel rail mills, burr mills, ore docks, coal docks and a gas plant. This report further states that the plant will utilize 7,000 horse power, which will be developed from either Dog Lake or the Nepigon river. The preference is given to the Nepigon river as a source of electrical energy. This development will mean an additional expenditure of approximately $2,000,000.

The gas plant will be one of the best in Canada. The company will dispose of the surplus supply to the citizens at a nominal price. Part of the plant will be erected on the property at present owned by the company on the south side of the Canadian Northern elevators, and for the other works the company is negotiating with the city council for land near Bare Point. It is not yet known the extent of the property required, but the company will ask for certain bonuses.

COKE PRODUCTION OF CANADA.

The statistics of coke production in Canada as compiled by Mr. John McLeish, B.A., in his report to the Department of Mines, Ottawa, do not include coke made as a by-product in the manufacture of illuminating gas but are restricted to the record of the output of "oven coke" produced chiefly for metallurgical purposes.

The total output of coal in 1910 was 901,269 tons produced from 1,373,793 tons of coal; of which 875,310 tons were produced from domestic coal and 25,959 tons from imported coal. In 1909 the total production was 871,727 tons produced from 1,327,150 tons of coal.

The quantity of coke sold or used by the producers in 1910 was 902,715 tons, as compared with 862,011 tons in 1909. The consumption of coke in Canada is much in excess of the domestic production, there being a considerable importation of coke chiefly into Ontario and Quebec for use in the metallurgical industries.

The imports of coke during the calendar year 1910 were 737,088 tons and the exports 57,971. These figures taken in conjunction with the production of 902,715 tons (sold or used), would indicate a consumption of 1,581,832 tons. Similarly estimated the consumption in 1909 was 1,449,369 tons, and in 1908, 1,285,228 tons.

Coke is made in Nova Scotia, principally at Sydney and Sydney Mines, but also at Westville, Stellarton, and Londonderry. This province in 1910 produced about 56 per cent. of the total for Canada, and the ouutput is used almost entirely in the manufacture of iron. In Ontario coke is made by the Atikokan Iron Company at Port Arthur for use in the company's blast furnace. By-product ovens are also being erected by the Algoma Steel Company at Sault Ste. Marie, to supply fuel for the company's blast furnaces. For both these plants coal is imported from the United States. In Alberta coke ovens are operated at Coleman and Lille near Blairmore, and in British Columbia at Fernie, Michel, Carbonado, and Hosmer in the Crows Nest Pass, and at Union Bay, Vancouver Island. The coke output of these provinces is used chiefly by the copper and lead smelters; finding a market in the United States as well as in British Columbia.

The total number of ovens in active operation on December 31 was 1,678; while 1,086 were reported idle on the same date, and 230 in course of construction. In Nova Scotia the Dominion Iron and Steel Company at Sydney has 500 finished ovens and 120 in course of construction, all of the Otto Hoffman by-product type. The by-products from these ovens include tar and ammonia. The tar is sold to the Dominion Tar and Chemical Company, whose works are contiguous to the coke oven plant, and this product is further treated for the manufacture of refined tar, pitch of various grades, benzole, creosote, carbolic acid, etc. The production of tar in 1910 was 3,963,591 gallons, and ammonia liquor containing 3,491 tons of sulphate of ammonia.

In 1909 the production of tar was 4,016,824 gallons, and of sulphate of ammonia 3,351 tons; and in 1908, tar 4,450,166 gallons, and sulphate of ammonia 2,984 tons. The Nova Scotia Steel and Coal Company has 30 ovens of the Bauer type and 120 Bernard ovens; the latter are situated near the furnace and the surplus gas is used for the production of steam for the electric power plant. The surplus gas from the Bauer ovens is used in generating steam for general colliery use. The other ovens in this province number 178 and are all of the beehive type. The Atikokan Iron Company, Limited, has 100 beehive ovens at Port Arthur, Ont., and the Algoma Steel Company is erecting 110 Koppers by-product regenerative coke ovens at Sault Ste. Marie. The company has acquired and is operating coal lands in West Virginia for supply of coal.

In Alberta the West Canadian Collieries, Limited, at Lille, has 50 ovens of the Bernard or Belgian type. The ovens of the International Coal and Coke Company at Coleman, 216 in number, are the ordinary beehive as are also the ovens in British Columbia, comprising 1,420 in the Crow's Nest district and 150 on Vancouver Island.

Coke is manufactured from coal mined in five of the coal basins in Canada, viz.: the Sydney field, the Pictou field, both in Nova Scotia; the Frank-Blairmore field in south-western Alberta; the Crow's Nest field in East Kootenay, and the Comox field on Vancouver Island, both of the latter in British Columbia.

In the Sydney field the ovens used are all by-product ovens, whereas the coal of the Pictou field is made into coke in beehive ovens. A certain amount of Springhill coal, Cumberland field, is mixed with this coal, which it has not been possible to separate to calculate the yield in coke.

In the Blairmore field both Belgian ovens and beehive ovens are used. On Vancouver Island the coke is made in beehive ovens.

It may be interesting to point out that in this last field, only the fine screenings are used in the manufacture of coke. This coal is thoroughly washed before being charged into the ovens, and the refuse resulting from this treatment often amounts to 50 per cent. This refuse is rejected, and only the washed coal is charged into the ovens. The yield is computed from the quantity of washed coal.

THE PERMANENT EXPOSITION OF RAILWAY SUPPLIES.

Railway men in all sections of the country are evincing interest in the Permanent Manufacturers' Exhibit Railway Supplies and Equipment which is established in the Karpen Building, 900-910 South Michigan Boulevard, Chicago. This Exposition, which covers the entire 12th floor of one of Chicago's more recently constructed office buildings, is intended to be a permanent showing of machinery, equipment and supplies of every character used by the modern railway system.

A floor space containing over twenty-six thousand square feet has been divided into booths of various sizes to suit the requirements of the exhibitor. The booths are separated by heavy brass rails and each is furnished with standard equipment. As a result, all booths will be uniform and all appointments, including signs, will be of the same uniform character.

It is intended to make this exhibit the headquarters of visiting railway men, and to this end ample facilities have been provided for their entertainment. In connection with the Exposition, there are assembly and committee rooms. These have been placed at the disposal of the various railway organizations for meeting and convention purposes. The assembly room is capable of seating 400 people and has perfect light and ventilation, together with every facility for the transaction of association business. The club rooms have all the appointments of a modern club, and it is expected that this feature will attract a large number of visiting railway men to the Exposition.

Many of the largest firms in the country manufacturing supplies and equipment have already contracted for space in the Exposition, and a considerable number of exhibits have been installed. More are being placed daily, and by the time the Exposition is thrown open to the public on March 16th—which date has been set for the opening—every inch of floor space will be occupied.

The displays will be of a diversified character, and practically every line of the railway supply trade will be re-

presented. Working models of various devices will be shown, and some of the manufacturers are installing very elaborate displays of their goods.

The object of the exposition is to show under one roof practically every line in which railway men are interested. The educational value of the Exposition will be considerable, inasmuch as new devices will be displayed here as soon as they are brought out and the railway interests of the country will have an opportunity of inspecting the various lines without the expenditure of the time and money which would be required to visit the headquarters of the manufacturers. All of the space of the present floor will be devoted to machinery and the like, and plans are already being made to broaden the scope of the Exposition by the addition of another floor, which will be devoted exclusively to maintenance of way equipment.

ELEVATORS FOR C.P.R. BUILDING, TORONTO.

The new Canadian Pacific Railway Office Building at the southeast corner of King and Yonge Streets, Toronto, will be one of the notable features of that city. Its sixteen stories, for example, will tower above the fifteen stories of its neighbor, the Traders Bank Building, which now holds the record for height. The elevator service will naturally be of the utmost importance to the success of the building for office purposes, and the company has decided to spare no expense on the installation. After careful investigation the company chose the plunger type of elevator, and awarded the contract to the John McDougall Caledonian Iron Works Company, Limited, of Montreal.

There will be five hydraulic direct plunger elevators with the necessary pumping and signaling equipment. Three of these elevators for passenger service will have a lift of 188 feet and one of them a lift of 199 feet. The fifth, used for ashes, etc., will have a smaller lift. As they will be plunger elevators it will be necessary to sink wells of corresponding depth and line them with steel pipe casing. The passenger elevators will, of course, be provided wih every modern device to secure speed and safety in operation, including automatic limit stops which, quite independently of the operator, will slow the speed down gradually at the top or bottom without any shock or vibration. The elevators will be operated by Worthington compound steam pumps, and will be directed by an elaborate flash light signal system. In general features these elevators will be similar to those built by the same company for the new C.P.R. Windsor Station, Montreal.

ENGINEERING NOTES.

Edmonton, Alta.—The revenue from the operation of the municipal street railway for January, 1912, amounted to $26,408, an increase of 81 per cent. over January, 1911.

Newfoundland.—The Governor of this colony, Sir Ralph Champney Williams, announces the intention of the government to extend the roads, build additional costal steamers and improve the telephone and telegraph systems.

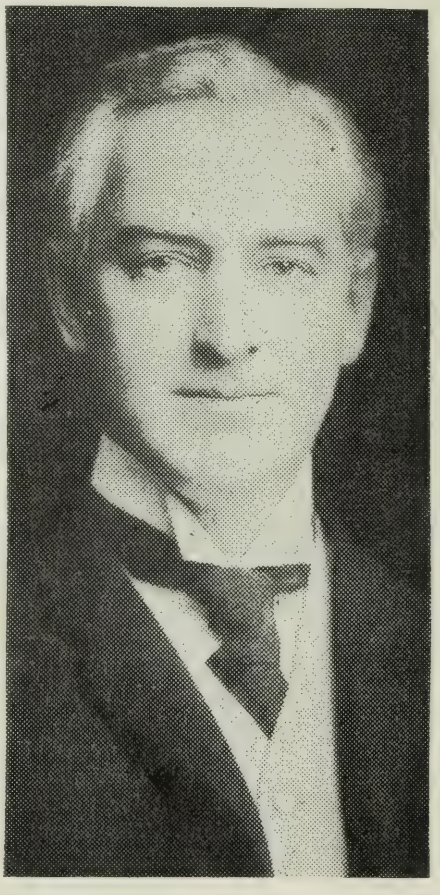
Union Bay, B.C.—A dam at a small lake near Union Bay was destroyed on February 12 last. The cause of the disaster is believed to be heavy rains. The dam was used to generate power for the plant of the Canadian Collieries and was owned by Mackenzie & Mann.

Railway Locomotives.—Canadian railways within the past two months have ordered two hundred and sixty new locomotives, representing a capital outlay of about four million dollars. Of the total 175 are for the Canadian Pacific, 85 being from the American Engine and Locomotive Company, and the rest from Canadian shops, sixty for the Canadian Northern, and twenty-five for the Grand Trunk Pacific.

Vancouver, B.C.—A new gasometer being erected for the Vancouver Gas Company will have a capacity of 2,000,000 cubic feet of gas. It has a diameter of 150 feet and the steel towers of the structure rise to a height of 160 feet from the foundation line. Each of the telescopic lifts of the holder is 31 ft. 6 in. in depth and fitted with the latest types of guides, rollers, carriages, etc., from its up and down movement as limited by the lofty guide frames when a fresh supply of gas is poured in or the storage supply is drawn upon. The water tank on the ground level is of a depth of 32 ft. 6 in. and is formed of steel plates varying in gauge from ⅞ to ⅜-inch. The capacity of this water tank is approximately 3,500,000 gallons. When the new gas holder is in service the company will have at its command a storage capacity equivalent to two and a half days demand at the present rate of consumption of gas in the city.

PERSONAL.

Mr. T. Kennard Thomson, a graduate of Toronto University, has made a specialty of tall building foundations. As an authority on caisson air chambers he is known to many owners of financial buildings in lower New York. Among many of these buildings, which have had their foundations examined and planned by Mr. Thomson, are the Manhattan Life Building, the Civic Investment Building, the Trust Company of America, the Singer Building, and the Tower of Liberty. Mr. Thomson was born in Buffalo, 1864.



Mr. K. S. Macdonnell, municipal engineer for the City of Collingwood, Ont., has tendered his resignation, to take effect March 1st.

Mr. J. T. Arundel, of Winnipeg, has been appointed superintendent of the Ontario division of the Canadian Pacific Railway.

J. R. Wemlinger, president Wemlinger Steel Piling Company, 11 Broadway, New York, has been re-elected secretary of the American Society of Engineering Contractors, with headquarters at 13-21 Park Row, New York.

Alexander Potter, consulting engineer, 114 Liberty Street, New York, has just been retained by the City of San Antonio, Texas, to make an appraisement of existing waterworks owned by San Antonio Water Supply Company, and to prepare plans for future extensions. Mr. Potter has also just recently been engaged by the City of Springfield, Mo., to design sewage disposal plans for two extending outlets, one to the north and one to the south.

CANADIAN MINING INSTITUTE.

The provisional program for the annual meeting at Toronto is as follows: Wednesday, March 6, at 10 a.m., business meeting, at which the usual current business will be dispatched, the presidential address delivered, and the mineral statistics for 1911 presented. In the afternoon there will be a meeting for reading and discussion of papers; and in the evening Dr. W. H. Tolman, director of the American Museum of Safety, will deliver an illustrated address on "Accident Prevention." On March 7 there will be morning and afternoon sessions for reading and discussion of papers, and in the evening a smoking concert. On March 8, morning and afternoon sessions for reading and discussion of papers, and for the dispatch of any unfinished business will be held. In the evening the meeting will close with the annual dinner.

INTERNATIONAL GEOLOGICAL CONGRESS.

Dean Adams, of McGill University, presided at a meeting in Montreal the other day of representatives of the Canadian Mining Institute and the railways to make preliminary arrangements for the entertainment of the numerous delegates coming from all over the civilized world to attend the International Geological Congress, to be held in Montreal in the summer of 1913.

The ten days' sessions are to be held in Toronto, but the delegates will foregather in Montreal for two weeks prior to these meetings, and will undertake excursions into all the surrounding country interesting from a mineral or geological point of view. It is expected that there will be over 700 delegates from outside countries, including Great Britain, Germany, France, Spain, Italy, Finland, Russia, Servia, India, Africa, Australasia, China, Japan, Belgium, Sweden, and other places. There will also be delegates from all parts of North and South America, so that over 1,000 will be in session. From Montreal excursions are to be made to the Maritime Provinces, to the Haliburton and Bancroft area, to Sudbury, Cobalt and Porcupine, to Thetford Asbestos Mines, to the St. Marguerite and St. Jerome anorthosite deposits, to the Monteregian Hills, and to the Ottawa and Kingston districts. During the sessions in Toronto, excursions will be made to different parts of Ontario, and after the sessions there will be excursions to the Pacific Coast, the Yukon and Alaska Districts, and to the Peace River and Athabasca regions.

The Dominion Government has already taken steps for the entertainment of the visitors, and to help in showing them the mineral resources of the country, and it is believed the visit of so many famous geologists will have an important effect on the future development of the country.

MEETING OF OTTAWA BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

A meeting of the Ottawa branch of the Canadian Society of Civil Engineers was held on February 5th, to discuss the action taken at the annual meeting in regard to the erection of a headquarters building at Montreal. The following motion by Mr. Noulan Cauchon, seconded by Mr. A. A. Dion, was carried:

"That it is the opinion of the Ottawa branch of the Canadian Society of Civil Engineers, that in view of the fact that the branches are not getting sufficient funds for their proper maintenance and progress:

"That this branch views with regret as hasty the action taken by the annual meeting in voting to dispose of practically all the funds of the society for a new headquarters without taking a ballot of the society on the subject."

It was moved by Mr. G. B. Dodge and seconded by Mr. S. S. Johnson, "That the above motion be forwarded to all other branches of the society."

ANNUAL MEETING OF AMERICAN ROAD BUILDERS' ASSOCIATION.

The annual meeting of the American Road Builders' Association was held at the Hotel Astor, New York City, N.Y., February 2nd. At this meeting reports of the executive committee, the secretary, and the treasurer were presented. Their reports showed a very healthy and substantial growth during the past year, the membership having increased very materially. Prospects for a much larger increase the present year are exceedingly bright.

The election of the officers of the association is by letter ballot. At this meeting the ballots were counted and officers were declared elected as follows:—

President, Nelson P. Lewis, Chief Engineer Board of Estimate and Apportionment, New York City.

First Vice-President, Harold Parker, Ex-Chairman Mass. State Highway Commission, Worcester, Mass.

Second Vice-President, J. D. Meriwether, Territorial Road Engineer, Socorro, N. Mexico.

Third Vice-President, W. A. McLean, Provincial Engineer of Highways of Ontario, Toronto, Ont., Canada.

Secretary, E. L. Powers, Editor and Publisher "Good Roads," New York City, New York.

Treasurer, W. W. Crosby, Chief Engineer State Roads Commission, Baltimore, Md.

Directors for Three Years: A. W. Dean, Chief Engineer, Massachusetts Highway Commission, Boston, Mass. F. D. Lyon, Deputy Commissioner of Highways, Albany, New York. P. L. Hardison, State Highway Commissioner, Augusta, Maine. S. D. Foster, Chief Engineer Highway Dept., Harrisburg, Pa. W. J. Roberts, State Highway Commissioner, Olympia, Washington.

Clifford Richardson, Consulting Engineer, New York City, N.Y.

MEETINGS.

Major W. R. Lang addressed the Engineers Club on the evening of February 15th and drew the attention of that body to the establishment of military engineering units of

service to the infantry. Major Lang stated that the proportion of engineers to infantry in Canada was far too small, and advocated the extension of this branch of the service.

Professor A. P. Coleman, University of Toronto, addressed the members of the Canadian Clay Products Association at Halifax, N.S. He selected as his subject "The History and Nature of Clay."

Professor Parker delivered a lecture on the "Chemistry of Flames" before the public, at the University of Manitoba, on February 9th last. The address was illustrated by experiments, etc.

Mr. Collingwood Schreiber, C.M.G., read a paper on "The Development of Transportation Facilities in Canada" before the Canadian Society of Civil Engineers, at Montreal, on the evening of February 8th last. The construction of small canals in the 18th century in Canada around some of the rapids of the St. Lawrence and Ottawa Rivers, up to the construction of the Coteau de du Lac and Split Rock Canals in 1779, their enlargement in 1814 to 1817, and the making of the Vaudreuil, Lachine, Welland, Carillon and Grenville, Rideau, Trent, and Cornwall Canals, were traced by the speaker, who also referred to the development of the railway system from the first line constructed in 1836 between Laprairie and St. John, up to the present day.

COMING MEETINGS.

THE UNIVERSITY OF TORONTO ENGINEERING SOCIETY.—Open Meeting of Engineering Society at 4 p.m., Thursday, Feb. 22nd, 1912, in Convocation Hall. Mr. Frank B. Gilbreth, Efficiency Engineer and Contractor, New York City, will lecture on the subject of "Scientific Management." Cor. Secretary, Allan A. McQueen.

THE CLEVELAND ENGINEERING SOCIETY. Special Meeting February 27, 1912, Chamber of Commerce Building, Cleveland, O. "Technical Education (Illustrated)," by Prof. J. F. Barker, Technical High School, Cleveland. Secretary, F. W. Ballard.

ONTARIO GOOD ROADS ASSOCIATION.—Annual Convention to be held at Toronto, February 26, 27, 28. Secretary, J. E. Farewell, Whitby.

ASSOCIATION OF ONTARIO LAND SURVEYORS.—Annual Meeting to be held in Lecture Room, Engineers' Club, 96 King Street West, Toronto, on Feb. 27, 28 and 29. Secretary, Killaly Gamble, 703 Temple Bldg., Toronto

THE ENGINEERS' CLUB OF TORONTO, 90-96 King St. West.—Thursday, Feb. 29th, 8 p.m. Meeting of Toronto Branch of Canadian Society of Civil Engineers. R. B. Wolsey, Secretary.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—**President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.**

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—**President, G. M. Lang;** Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—**President, J. L. R. Parsons, Regina;** Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—**President, N. McMurchy;** Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—**President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.**

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—**President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.**

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—**President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.**

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—**President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.**

CANADIAN ELECTRICAL ASSOCIATION.—**President, N. W. Ryerson, Niagara Falls;** Secretary, T. S. Young, **Canadian Electrical News, Toronto.**

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—**President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.**

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—**President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.**

CANADIAN MINING INSTITUTE.—**Windsor Hotel, Montreal. President,** Dr. Frank D. Adams, McGill University, Montreal; Secretary, H Mortimer-Lamb, **Windsor Hotel, Montreal.**

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. **Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.**

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary, R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Calgary, Alta., electric machinery	Mar 15.	Feb. 8.	68
Calgary, Alta., sluice gates	Feb. 29.	Feb. 1.	68
Galt, Ont., Y.M.C.A. building	Feb. 24.	Feb. 1.	59
Edmonds, B.C., steel pipes	Mar. 11.	Feb. 8.	68
Hamilton, Ont., waterworks extensions	Feb. 28.	Feb. 15.	68
Keremos, B.C., quarantine station	Mar. 1.	Feb. 8.	59
Lockport, Man., Red River bridge work	Feb. 20.	Feb. 8.	59
Meaford, Ont., construction work on E. Breakwater; dredging	Feb. 26.	Feb. 1.	59
Moose Jaw, Sask., elevated water tank	Feb. 26.	Feb. 8.	68
Milton, Ont., concrete arch and viaduct	Mar. 4.	Feb. 15.	70
New Westminster, B.C., dams and excavation work	Mar. 10.	Feb. 15.	59
Ottawa, Ont., launches	Feb. 24.	Feb. 1.	59
Ottawa, Ont., contracting machinery	Feb. 26.	Jan. 11.	59
Saskatoon, Sask., subway	Feb. 23.	Jan. 25.	68
Saskatoon, Sask., waterworks materials	Mar. 1.	Feb. 15.	68
Saskatoon, Sask., electrical machinery	Mar. 8.	Feb. 15.	68
Saskatoon, Sask., electrical supplies	Feb. 22.	Feb. 15.	70
Sault Ste. Marie, Ont., approach to wharf	Feb. 28.	Feb. 15.	59
Swan River, Man., schoolhouse	Feb. 29.	Feb. 15.	60
Toronto, Ont., track intersections, etc.	Feb. 20.	Jan. 25.	72
Toronto, Ont., bridges	Mar. 2.	Feb. 1.	59
Toronto, Ont., sewer, Toronto Junction	Feb. 27.	Feb. 8.	68
Toronto, Ont., annual supply of asphalt	Feb. 27.	Feb. 15.	70
Toronto, Ont., Coxwell Ave. subway	Mar. 7.	Feb. 15.	70
Windsor, Ont., fittings in drill hall	Feb. 22.	Feb. 15.	59
White Rock, B.C., quarantine station	Mar. 15.	Feb. 15.	59
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., pumping machinery	Mar. 1.	Jan. 25.	72
Winnipeg, Man., steam shovel equipment	Mar. 1.	Feb. 15.	60
Winnipeg, Man., cables	Mar. 25.	Feb. 15.	60
Winnipeg, Man., transformers, motor, etc.	Feb. 22.	Feb. 15.	60
Winnipeg, Man., waterworks materials	Mar. 1.	Feb. 15.	60
Victoria, B.C., St. John's Church edifice	Mar. 5.	Feb. 15.	60

COPIES WANTED.

Copies of our issue of February 1st and 8th are required. Parties sending in same will be allowed the usual extension in their subscription.

TENDERS.

Brantford, Ont.—Tenders will be received up to Friday noon, 23rd February, 1912, for the construction of concrete abutments for a bridge to be built for the municipality of the township of Brantford over Fairchild's Creek. Plans and specifications to be seen at the office of James A. Smith, township clerk, Brantford.

Brantford, Ont.—Tenders will be received until February 29, 1912, for the supply of sewer pipes required by the City of Brantford during 1912. T. Harry Jones, city engineer, City Hall, Brantford. (See advertisement elsewhere in Canadian Engineer.)

Calgary, Alta.—Tenders for one or more of the following buildings will be received at the office of C.P.R. Division Engineer, Calgary, up to noon February 24th, 1912, for the erection and completion of the following buildings: Western Lines Class "A" Station at following points:—Webb, Namaka, Seven Persons, Winnifred, Dunmore, Clive, Nevis, Lougheed, Aldersyde, Jeffray, Burmis and Galloway. Also a Western Lines Standard No. 5 Sattion at Yahk. Plans and specifications can be seen at Chief Engineer's Office, Winnipeg; Resident Engineer's offices at Cranbrook and Medicine Hat, and this office. N. E. Brooks, C.P.R. Division Engineer, Calgary.

Calgary, Alta.—Tenders will be received until noon of May 1st, 1912, for proposals for Brooks Aqueduct. Plans, etc., may be obtained on application to A. S. Dawson, chief engineer, C.P.R., Calgary. (See advertisement elsewhere in Canadian Engineer.)

Edmonton, Alta.—Tenders will be received until March 15th, 1912, for the manufacture of all steel highway bridges required for the year 1912. Specifications, etc., may be had from the Structural Engineer's Office, Department of Public Works, Edmonton. John Stocks, Deputy Minister of Public Works, Edmonton.

Moose Jaw, Sask.—Tenders will be received until March 18th, 1912, for laying about 96,000 lineal feet of 18-inch steel water pipe. E. B. Bonnell, City Clerk, Moose Jaw. (See advt. elsewhere in Can. Eng.)

Montreal, Que.—The Canadian Pacific Railway are contemplating the erection of a steel bridge, grading, etc., at Ingersoll, Ont. Estimated cost, $30,000. Supt. in Charge, Mr. Hodge, London.

Ottawa, Ont.—Tenders will be received until March 4, 1912, for the supply of coal and fuel wood required to heat the military buildings at Toronto, Hamilton, Brantford, St. Catharines, Dundas, and Burford, Ont., for the year ending March 31st, 1913. Full particulars to be had on application to the director of contracts, Militia Headquarters, Ottawa, or at the office of the Officer Commanding 2nd Division, Toronto. Eugene Fiset, Col., Deputy Minister of Militia and Defence, Ottawa.

Ottawa, Ont.—Tenders will be received until March 6th, 1912, for the construction of a dormitory, Royal Military College, Kingston, Ont. Plans, etc., may be obtained on application at the office of Messrs. Power & Son, architects, Kingston, Ont., and at the office of R. C. Desrochers, secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until March 11th, 1912, for the construction of two 150 cubic yards capacity steel hopper scows. Plans, etc., can be obtained at the offices of J. G. Sing, Esq., District Engineer, Toronto; J. L. Michaud, Esq., District Engineer, Merchants Bank Building, Montreal; G. G. Scovil, Esq., Superintendent of dredges, St. John, N.B.; and G. M. Graham, Superintendent of dredges, New Glasgow, N.S. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the construction of a Dormitory, Royal Military College, Kingston, Ont., will be received

until March 6th, 1912. Plans, etc., may be obtained at the office of Messrs. Power and Son, architects, Kingston, Ont., and at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

St. Andrews, N.B.—Tenders will be received by D. C. Rollins, secretary to School Board, St. Andrews, until noon March 11th, 1912, for the erection and furnishing of a school building in that town.

St. Catharines, Ont.—The city council of the city of St. Catharines invite tenders for about 200 cu. yds. of 2-inch crushed stone in carload lots, as required, f.o.b. St. Catharines. Tenders to be in not later than February 28th, 1912. R. D. Brown, City Engineer, St. Catharines. (See advt. in Can. Eng.)

St. Catharines, Ont.—Tenders will be received by the architect until March 12th, 1912, for the erection and completion of Holy Trinity Church, Welland, Ont. A. E. Nicholson, architect, 46 Queen St., St. Catharines, Ont.

Toronto, Ont.—Tenders will be received until Feb. 27th, 1912, for (1) mason work, etc.; (2) painting and glazing in connection with the new Police Station on Claremont Street. Plans, etc., at the office of the City Architect, Toronto. G. R. Geary (Mayor), Chairman Board of Control, City Hall, Toronto.

Toronto, Ont.—A recommendation has been passed by the Works Committee that a new concrete bridge be built over the Don River at Gerrard Street, costing $200,000.

Toronto, Ont.—Tenders will be received until March 12th, 1912, for the construction of a storm overflow sewer, Barton Avenue, section No. 2. Specifications at the office of the City Engineer, Toronto. G. R. Geary (Mayor), Chairman Board of Control, City Hall, Toronto. (See advt. in Can. Eng.)

Vernon, B.C.—Tenders will be received until March 11th, 1912, for the construction of vitrified pipe sewers. Plans and specifications, with form of tender, may be obtained at the office of the City Engineer, City Hall. D. G. Tate, City Clerk, City Hall, Vernon, B.C.

Westmount, Que.—Tenders will be received until March 11th, 1912, for the construction of the following works: A, contract No. 13, intercepting sewer, Western Avenue. B, contract No. 12, paving of Western Avenue. Drawings, etc., at the office of Archibald Currie, C.E., City Surveyor, Westmount. (See advt. in Can. Eng.)

Winnipeg, Man.—Tenders will be received until February 26th, 1912, for the supply of labor and material required for the erection of fender for the Redwood Bridge. Plans, specifications, etc., may be obtained at the office of the City Engineer, 223 James Avenue. M. Peterson, Secretary Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received by the Chairman of the Board of Control until March 7th, 1912, for supply of five 36-inch and three 20-inch gate valves. Specifications and form of tender may be obtained at the office of the City Engineer, 223 James Avenue. M. Peterson, Secretary Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received until March 1st, 1912, for the erection of an office building in the City of Edmonton, Alta., for the Canadian Pacific Railway Company. Plans and specifications and steel diagrams for purpose of tendering can be obtained at the office of William Wallace Blair, architect, 400 Nanton Building, Winnipeg.

CONTRACTS AWARDED.

Acton, Ont.—Mr. Geo. H. Tod, Canadian representative of Thos. Piggott & Co., Birmingham, has sold to the plant of the Beardmore Belting Company, a Piggott tank of 35,000 gallons capacity.

Calgary, Alta.—The contracts for digging the trench in which the big steel main for the Canada Western Natural Gas, Heat, Light and Power Company, from Bow Island to Calgary, will be laid, a distance of 170 miles, has been awarded in two sections to W. F. Cochrane, of Pittsburg, Pa., and J. Driscoll, of Indianapolis. The cost will be $350,000.

Calgary, Alta.—The City Commissioners have awarded the tender for the construction of the bridge over the Bow River to the C.P.R. Carshop District, to the Algoma Bridge Company, whose tender amounted to $64,300. Among those who submitted tenders for the erection of this bridge were the following firms: Cleveland Bridge Company, Canada Foundry Company, Dominion Bridge Company, Canadian Fairbanks, and G. Webster.

Haliburton, Ont.—The two bridges over the Burnt River, one 100 ft. clear span, steel bridge, the other 50 ft. clear span, reinforced concrete truss bridge, are being built by day labor under the engineer's supervision, except the steel, the contract for which has been awarded to the Dickson Bridge Works Co. at $4,185.

Ottawa, Ont.—The Department of Railways has paid Mr. W. B. Russell, the contractor for the Newmarket Canal, one thousand dollars as compensation for the cancellation of the contract for finishing the canal. Mr. Russell, in addition, receives the contract for rebuilding all the bridges over the canal, and repairing the highways demolished by construction work. He is to receive fifteen per cent. above the cost of such work. The engineers' report on the canal will show that over eighty per cent. of the work has been done, and that the amount required to complete the canal would be about $200,000.

Port Alberni, B.C.—First class 200-room hotel; Messrs. George C. Mesher & Company, architects and builders; Mr. A. E. Waterhouse, proprietor.

Quebec, Que.—Messrs. J. H. Gigorac & Company have received the contract for the Bascule Steel Bridge over St. Charles River. Estimated cost, $145,010. City Engineer, W. D. Baillairge.

St. Catharines, Ont.—Messrs. L. O'Connor and L. Binns, of Johnston & Jenkins, of New York, have the contract of installing the steam and machine heating plant in the new factory building on Vine Street for Canadian Yale Towne, Ltd.

Victoria, B.C.—The contract for the construction of the Hibben Block on Government Street, a modern fire-proof brick and concrete structure with marble facings and linings in the corridors, heavy stones, cornices, and carved capitals, has been awarded to the Westholme Lumber Company of this city. The contract price is $88,000. Other tenderers for the work included Messrs. Luney Bros., and Thomas Catterall.

West Toronto, Ont.—Messrs. Wells & Gray, Ltd., Confederation Life Building, have been awarded the contract to erect a cold storage warehouse for the Swift Canadian Company.

RAILWAYS—STEAM AND ELECTRIC.

Berlin, Ont.—The directors of the Berlin and Bridgeport Street Railway will make application to the Provincial Government for powers to extend the line to Elora, Ont. W. H. Breithaupt is president of this company.

Brandon, Man.—The municipal council intend to grant the street car franchise to Mr. J. D. McGregor. Terms will be arranged at an early date.

Hamilton, Ont.—City Engineer Macallum will prepare a map showing proposed extensions of the civic car lines.

Montreal, P.Q.—The municipal council are making application to the legislature for power to construct an underground railway.

Toronto, Ont.—The Toronto Suburban Railway Company intend to petition the Provincial Government for powers to construct a line of railway from a point on its Toronto-Hamilton line in Toronto Township, Peel County, to Brampton, and thence easterly and southerly back to Davenport.

LIGHT, HEAT AND POWER.

Lindsay, Ont.—The Seymour Power Company, according to report, will erect a sub-station in connection with the company's transmission line from Peterboro to Lindsay. It is understood that the Seymour Company will bring the power from Peterboro at 12,000 volts, with a step down at the sub to 4,000 volts. Mr. J. S. Denik, of Trenton, is the company's official in charge of the work at this point.

Peterborough, Ont.—The municipality of Peterborough seeks authority from the Provincial Government to expropriate the plant and property of the Otonabee Power and Light Company.

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Lancaster St., Berlin, Ont. Constructed with Tarvia X Modern Pavement

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TARVIA is a powerful binder for the surfaces and foundations of macadam roads. It fills the voids and locks the stone in a tough, durable, plastic matrix.

A Tarviated surface looks like sheet asphalt and is equally dustless and clean. It sheds water readily and is dry immediately after the rain, so that pedestrians are not inconvenienced. The surface never gets muddy or dusty.

On account of the Tarvia matrix, these roads will bear heavier automobile traffic than plain macadam because the surface yields instead of pulverizing under the strains. The Tarvia matrix prevents internal movement and grinding.

The plasticity of the Tarvia also makes these roads very quiet. Horses' hoofs make almost no sound on a Tarviated road. Tarvia is waterproof, and Tarviated roads, therefore, are protected against damage from torrents on grades.

Tarvia has no odor except when being applied. After it hardens, it has no injurious effect on shoes, clothing or vehicles. The cost of using Tarvia is not a factor for consideration, because it has been repeatedly demonstrated that it is cheaper to maintain a dustless road with Tarvia than a dusty one without it. Maintenance economies more than balance the additional cost.

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Montreal Toronto Winnipeg Vancouver

The Carritte-Paterson Manufacturing Co., Limited
St. John, N.B. Halifax, N.S.

St. Stephen, N.B.—This municipality has taken an option on the entire output of the Eel River Heat, Light and Power Company. Mr. R. G. Lee is secretary of this company. The proposed plant will have a capaity of about 3,000 horsepower.

GARBAGE, SEWAGE AND WATER.

Berlin, Ont.—The municipal Water Commission will reduce the rate to consumers.

Moose Jaw, Sask.—The municipal council will erect a large water tank at Sandy Creek. It is to have a capacity of 75,000 gallons.

Fort William, Ont.—City Engineer Wilson has stated that it will be necessary to construct a duplicate of the water supply pipe from Loch Lomond to the reservoir if the Canadian Pacific Railway continue to draw their supply from the civic mains.

North Toronto, Ont.—The municipality will construct a 6-inch water main on Roman Avenue. Mr. E. A. James, town engineer.

Port Stanley, Ont.—The plans for a new waterworks, prepared by J. Bell & Son, St. Thomas, have been approved by the municipal council. A by-law will be prepared and voted upon by the ratepayers. The cost is estimated at $22,000, and the plans include 21 hydrants, 600 feet of fire hose and an electric pump. Messrs. Gummond and Finlay, councilmen.

South Vancouver, B.C.—This section of Vancouver city has made an appeal to the council for a better water supply. Mr. Fellowes, City Engineer.

Toronto, Ont.—The estimates for the Board of Works include $145,200 for sewers and $7,458 for reservoir expenses. Mr. Fellowes, Engineer of Waterworks.

BUILDINGS AND INDUSTRIAL WORKS.

Berlin, Ont.—The Park Commission of this municipality will erect a $20,000 concrete grand stand. Work is to commence at an early date. Mr. H. Johnston, City Engineer.

Calgary, Alta.—Mr. J. W. Scott, of Winnipeg, Man., is taking steps to establish a tar and creosote factory at this point.

Galt, Ont.—The Galt Knitting Company, Ltd., are planning an addition to their premises. The addition will be 35 x 50, of sand lime brick.

Guelph, Ont.—Mayor Thorp has expressed his opinion to the effect that he is in favor of improving the fire fighting system and erecting a new fire station.

Highgate, Ont.—The British Canadian Canning Co. are taking the preliminary steps toward the erection of a cannery at this point.

Kingston, Ont.—The Buffalo Ontario Smelting Co. intend to erect a plant on Cataraqui Bay. W. W. Sands, M.D., municipal clerk.

Merritton, Ont.—A branch factory of the Presto Light Company of Indianapolis, Ind., will be established in this village. The building is to cost about $4,000.

Montreal, P.Q.—The Belgo-Canadian Company, manufacturers of steel, have been making enquiries relative to the establishment of a plant in the Maisonneuve district. A committee of the city council will report.

Moose Jaw, Sask.—The new building of the "Robin Hood Flour Mills" is to be a seven-story frame structure, metal clad, 112 x 54 feet. The elevator will be concrete built, consisting of from 12 to 15 concrete tanks, having a combined capacity of 250,000 bushels. A warehouse will be built, measuring 160 feet by 64 feet, consisting of four stories. Adjacent to this an oat mill will be built, a seven-story building measuring 96 feet by 64 feet, with a capacity of 500 barrels per day. Contracts will be let out for these buildings in a few weeks and construction will be rushed at full speed. Mr. C. E. W. Austin is interested.

Owen Sound, Ont.—The Board of Education will erect a $25,000 school building. Tenders will be called for at an early date.

Regina, Sask. — Messrs. Storey and Van Egmund are preparing plans for a hotel at Findlater on the C.N.R. north line.

Regina, Sask.—A large ice house and other buildings will be moved from their present position adjoining the Canadian Pacific Railway lines. Mr. S. Cox has the contract for the removal.

Saskatoon, Sask.—The Salvation Army intend to erect a $25,000 Citadel in this city. J. W. McBain, of Winnipeg, may build the structure. The Salvation Army also intend to erect buildings at Edmonton, Strathcona, Regina, and Moose Jaw. No definite plans for these structures have been completed.

Saskatoon, Sask. — Mr. David Webster, architect, has prepared plans for a $75,000 office building to be erected on 3rd Avenue and a $20,000 apartment block for Nutana. The owner of the apartment block is Mr. S. K. Clotworthy. At the present time, Mr. Webster is preparing sketches for three new schools for the city and he has also the work of preparing plans for two schools in outside places.

St. Catharines, Ont.—The plans for a structural steel erecting shop of the Canadian Crocker-Wheeler Co., together with plans for a fireproof japanning and impregnating building, have been prepared by E. D. Pitt, Niagara Falls, Ont., Engineer and Architect.

St. John, N.B.—Messrs. C. H. Peters' Sons, tanners, are contemplating enlarging their plant. They may erect a new structure and install new equipment.

Toronto, Ont.—New buildings for the exhibition grounds to be erected this year are to cost $55,000. Dr. Orr, exhibition manager.

Vancouver, B.C.—Messrs. Sullivan & Considine will construct a ten-story building for office and theatrical purposes. $350,000 will be spent on the structure.

Victoria, B.C.—Mr. W. Ridgway-Wilson is the architect for a new church to be erected in this city. The materials will be brick and terra-cotta.

Whitby, Ont.—The Ontario Government is considering the erection of an asylum near this town. The first portion to be constructed will accommodate 1,200 patients.

Winnipeg, Man.—The Manitoba Bridge & Iron Works intend to erect a new plant. Mr. T. R. Deacon is the president of this company.

Winnipeg, Man.—Messrs. J. W. & H. P. Frid, general contractors, have transferred their interests to the firm of The Frid-Lewis Company, Ltd.; capital, $150,000. The new firm has been organized for the purpose of entering the contracting and engineering business. Mr. F. C. Lewis will be in charge of the engineering department.

Woodstock, Ont.—There is some movement in this municipality to prepare a by-law calling for the erection of a $75,000 city hall. Ald. John Butler is interested in the project.

BRIDGES, ROADS AND PAVEMENTS.

New Westminster, B.C.—The municipal council have placed an order with Mussens Ltd., Montreal, for a 12-ton Rushton Proctor road roller with three tyne scarifier.

North Toronto, Ont.—The municipal council intend to have $6,300 worth of concrete walk laid in the near future. Mr. E. A. James, Engineer.

North Toronto, Ont.—This municipality will construct a $2,500 concrete bridge on Albertus Avenue. Mr. E. A. James, town engineer.

Oxford County, Ont.—Oxford County will seek powers from the Provincial Government to issue debentures to raise $133,467 for a county road system. Mr. N. E. Birtch, county clerk.

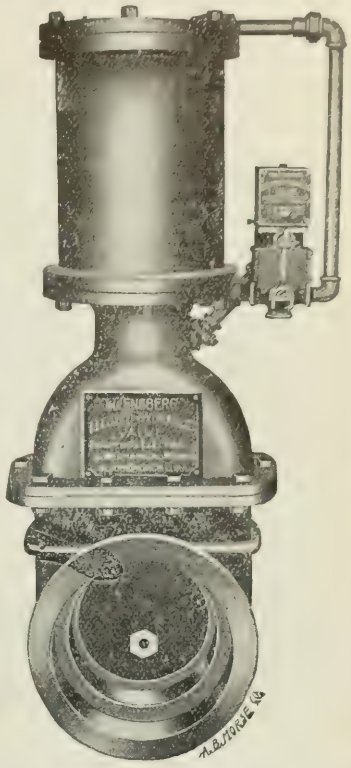
Stettler, Alta.—The Stettler district agricultural society intend making application for $10,000 for provincial road improvements. The application will be made to the department of Public Works.

Toronto, Ont.—The estimates of the Board of Works include $277,015 for new bridges, $51,752 for concrete sidewalks and $36,250 for street grading.

Toronto, Ont.—City Engineer Rust has recommended that a new concrete bridge be erected over the Don River at Gerrard Street. The estimated cost of the work is placed at $200,000.

Toronto, Ont.—Pavements on the exhibition grounds to be laid this year will cost $18,000. Dr. Orr, exhibition manager.

The "ENGBERG" VALVE



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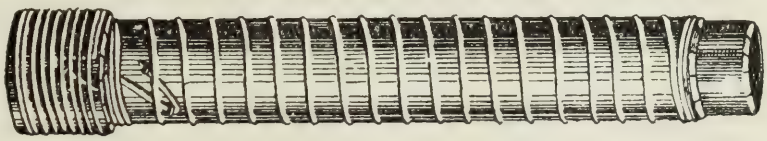

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FIRES.

Camrose, Alta.—A fire at the Round Hill Collieries caused $3,000 damage.

Montreal, P.Q.—The establishment of F. Thompson & Company, manufacturers of electric motors, was damaged by fire to the extent of $12,000.

Sherbrooke, Que.—$30,000 damage was caused by fire to a business block owned by Ald. D. McManamy. Commercial offices and stores occupied the block.

CURRENT NEWS.

Newcastle, N.B.—The dredging plant of A. & R. Loggie Company has been purchased, according to report, for $250,000.

Ottawa, Ont.—Civic supplies for 1912 will be supplied under the following prices:—Brick, the Peerless Brick Company, at $8.70 per 1,000. Castings, Messrs. Thos. Lawson & Sons, at $2.50 per 100 lbs. Sand, the Rideau Canal Supply Company, at $1.10 per cubic yard. Nepean stone setts, Saml. Bilsky, at $52.75 per 1,000 for ordinary setts, and $62.75 per 1,000 for track allowance blocks. Cement, H. Dupuis & Sons, at 50½c. per 100 lbs. Street sweepers' brooms, W. G. Charleson, at $9 per dozen. Vitrified clay pipe, T. S. Kirby Co., for Garthcraig. Scotch pipe at 54½ per cent. discount on price list. Asphalt, Canadian Mineral Rubber Co., Pioneer refined asphalt, $24.04 per ton; Elder Ebano Asphalt Co., Ebano Mexican asphalt, $25.60 per ton; the Barber Asphalt Paving Co., for Trinidad Pitch Lake asphalt, $27.25 per ton.

Toronto, Ont.—The revised building by-law will call for a more rigid inspection of concrete, and the construction schedule of concrete will be a little lighter.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ended January 29th, 1912. Fuller information may be obtained by communicating with the Department of Trade and Commerce, Ottawa.

A Yorkshire manufacturer of copper cylinders, washing coppers, towel rails, copper boilers, copper coils, furnace pans, tanks, etc., desires to appoint an energetic and reliable representative at Winnipeg.

A London firm are open to handle minerals or agricultural produce from Canada, either on commission or purchase basis.

A London firm having connections with Spanish shippers of fruit pulp are open to hear from Canadian jam manufacturers or other importers in the Dominion.

Inquiry is made by a correspondent in Italy for the names of reliable parties in Canada willing to act as agents for the sale of pure olive oil.

A Winnipeg firm are anxious to get into touch immediately with a United Kingdom potato merchant in a position to ship large supplies for the Canadian market.

A New Brunswick correspondent desires to dispose of a considerable quantity of sawdust and invites inquiries from United Kingdom importers.

A correspondent at Prince Rupert, B.C. (the terminus of the Grand Trunk Pacific Railway), is open to take up agencies for tool steel, belting, mine and mill supplies, piping (iron and clay), marine motors, concrete machinery, contractors' supplies, etc.

A Nova Scotia correspondent who is beginning the manufacture of men's and boys' braces, is desirous of being placed in correspondence with United Kingdom makers of buckles, webbing and leather trimmings.

A Nova Scotian, at present in Birmingham, is open to purchase supplies of cocoa and other fibre for brush making; also mop stick and broom handles.

An important Western Canadian firm of manufacturers' agents are desirous of securing United Kingdom agencies for mining machinery, tools and supplies of every description; gas engines; fire and steam hose for railways, etc.; briquette machinery; farm machinery; traction engines; fire extinguishers; chains; cotton waste; vacuum cleaners; automobile tires; gunpowder; firebricks; tiles; glass; and many other lines. A representative is now visiting Great Britain.

A Vancouver correspondent at present in London, desires agencies for dry goods, athletic and sporting goods.

A correspondent in the province of Quebec is desirous of getting into touch with the inventor of the English viscose-Stearn system of artificial silk; also with manufacturers of machinery for manufacturing this article.

A Vancouver correspondent wishes to get into communication with United Kingdom manufacturers requiring representation in British Columbia.

An Ottawa firm of mica miners desire to get into touch with United Kingdom buyers of ground and thumb-trimmed mica, in which they specialize.

From the Branch for City Trade Inquiries, 73 Basinghall Street, E.C.:

A manufacturing company in Sweden invite quotations from Canadian producers of maple rollers suitable for mangles and wringers.

A Glasgow firm wish to make arrangements for obtaining regular supplies of Canadian corundum, and would also be glad to hear from producers of alabastine, magnesite, manganese and asbestos.

The Swedish manufacturers of an incandescent oil lamp wish to arrange for its sale in Canada.

An English firm manufacturing hosiery yarns, Egyptian and super American cop, cone, cheese or hank, wish to get into correspondence with Canadian buyers.

A London business man who spends several months each year in visiting the fruit and grain growing districts of Ontario, Western Canada and British Columbia, would be glad to hear from makers of artificial manure, fertilizers, insecticides, hop and fruit washes, etc., who wish to have their specialties introduced.

A British Columbia firm which regularly covers the whole of Canada in the interests of a textile manufacturer, and claims a good connection, seeks the representation of an up-to-date Yorkshire manufacturer of low and medium priced fancy worsteds and serges.

A London business man who pays an annual visit to Canada and has many years' experience of Canadian trade, is open to represent manufacturers of stationery and fancy leather goods seeking business in Quebec, Ontario and the Northwest. References supplied.

A manufacturers' agent in Victoria, who covers British Columbia and Western Canada, is open to represent a few United Kingdom manufacturers, provided that he is granted the sole agency for the territory named.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ended February 5th, 1912. Fuller information may be obtained by communicating with the Department of Trade and Commerce, Ottawa.

A Scottish correspondent desires to arrange for the sale of the Canadian patent rights in a system of cold-resisting and heat-conserving applicable to hot pipes (air, steam or water), etc.

A Glasgow correspondent dealing in iron and steel goods of various kinds, desires to do Canadian business.

A North of England firm of veterinary preparation manufacturers desire to appoint buying agents having connections among horse owners in Canada.

A Coventry manufacturer of motor car radiators, lubricators, silencers, bonnets, tanks, wings and other auto parts, desire to introduce their goods into Canada.

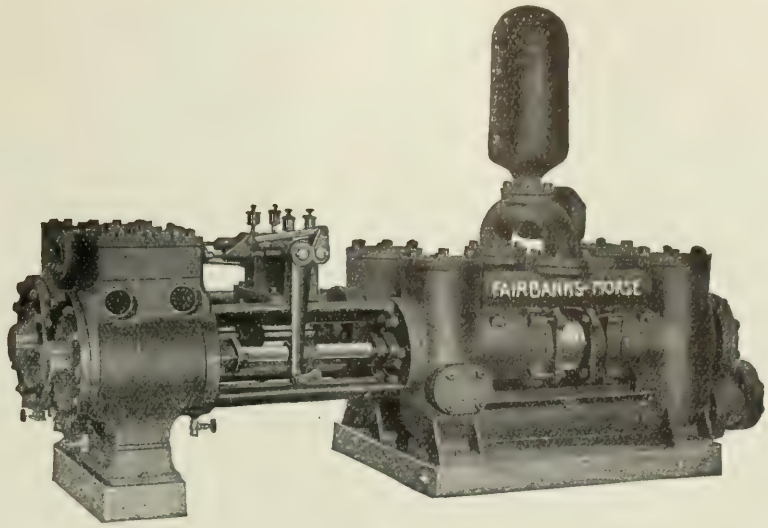
A Scottish firm are open to hear from Canadian importers of bottled castor oil.

A New Brunswick company manufacturing maple meat skewers desire to get into touch with London Indent Merchants in a position to arrange for the sale of such goods in Argentina, Australasia and South Africa.

A correspondent who is shortly returning to Canada wishes to secure the representation of United Kingdom firms open to do business in the Northwest or in British Columbia.

A Montreal firm of importers of English and French pharmaceutical products is open to take up United Kingdom agencies.

A Montreal firm make inquiry for the names of high-class United Kingdom manufacturers of travelling rugs suitable for automobile use.



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pumping machinery are largely due to the fact that for many years we have manufactured Hydraulic Machinery of all descriptions. We are therefore able to build pumps which are properly designed and adapted to every-day use. This is of the greatest importance in a first-class pump, for the usefulness of an engine may be lost if the pumping machine is badly designed.

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Let us solve your pump problems.

THE CANADIAN FAIRBANKS-MORSE CO. Limited

Fairbanks Standard Scales — Fairbanks-Morse Gas Engines.
Safes and Vaults.

Montreal Toronto Winnipeg Vancouver Calgary St. John, N.B. Saskatoon Ottawa

From the Branch for City Trade Inquiries, 73 Basinghall Street, E.C.:

A London company ask to be placed in touch with Canadian manufacturers of Kraft brown, news printing, and glazed colored papers, who can fill orders for shipment to Australia and New Zealand.

A Welsh company manufacturing patent solid woven machine belting, wish to get into touch with Canadian engineering and mill furnishing supply firms who can introduce this line.

A furniture manufacturing firm in Sydney, New South Wales, wish to obtain an agency for Canadian wooden chairs, upon a commission basis, and would like to receive catalogues from Canadian manufacturers interested.

A Glasgow firm ask to be placed in touch with Canadian producers of ochres, and are also interested in Kaolin.

A New Brunswick company manufacturing staves and headings would be glad to receive inquiries from United Kingdom importers. They can also supply large quantities of box shooks.

A New Brunswick company manufacturing spruce and white pine of all dimensions, also cedar railway sleepers and pine and cedar laths, would be glad to quote for all these lines.

EQUIPMENT FOR RUSSIA.

The management of this paper have an enquiry for the names of engineering firms prepared to tender for the supply of the following for Russia:—

(a) Electric furnace for scrap iron, 16-25 tons per diem.

(b) A rolling mill of smallest possible size (round) up to 3-inch diameter. (b) Rectangular 1⅞-inch by 1¼-inch and 1½-inch by 1⅝-inch.

(c) Bending and electric welding machines for chains from ⅛-inch to ½-inch.

(d) Stamp and forging machines for scythes, sickles and horse shoes.

(e) Lamps for giving about 200 candle-power from crude naphtha.

(f) Machine lathes for turning pick and axe handles (taper).

(g) Machines for making long boots of thick felt and similar materials.

Address in first instance to Box 100, Canadian Engineer, 62 Church Street, Toronto.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

15917—February 8—Extending until June 1, 1912, time for installation of interlocking plant by C.N.R. to cross C.P.R. near Forward, Sask.

15918—February 8—Approving location of C.N.R. station at Cylde, Alta.

15919—February 8—Authorizing C.P.R. to divert certain streams by means of 8-foot concrete culvert at mileage 110.1 on Cascade S.D., B.C. Division.

15920-21—February 8—Authorizing G.T.R. to reconstruct bridge over Mud River at mile post 4.87, Rockland Branch, and at mile post 8.06, Hawkesbury Branch, Ontario.

15922—February 8—Relieving C.P.R. from erecting fence, gates and cattle guards on B.C. Division, Laggan S.D.

15923—February 6—Authorizing village of Luseland, Sask., to construct highway across tracks of C.P.R. at mileage 15.95.

15924—February 10—Authorizing C.P.R. to use and operate five bridges on its Havelock & Toronto S.D., Ontario Division.

15925—February 10—Authorizing Pere Marquette Ry. to remove derails and signals from track connection C.P.R., and re-arrange interlocking in tower so that towerman can give freight trains a through route to and from the Windsor yard of the C.P.R. (Pere Marquette operating Lake E. & Detroit Ry.)

15926—February 5—Approving overhead crossing of Lake Erie & Northern Ry. over T.H. & B. and M.C.R. at village of Waterford, Ont.

15927—February 6—Authorizing Lachine, Jacques Cartier & Maisonneuve Ry. (G.T.R.) to cross tracks of C.P.R. in city of Montreal, at entrance to Angus and near Nolan St., and to take lands of C.P.R.. C.P.R. to re-arrange its spurs into Angus Shops, compensation to be fixed by agreement, etc.

15928—February 12—Rescinding Order No. 15254, October 11, 1911, re branch lines near Jex St., Brantford, Ont. G.T.R.

15929—February 12—Authorizing C.P.R. to cross with its Pheasant Hills Branch twenty-five highways, mileage 296.11 to 317.15, Saskatchewan.

15930—February 10—Authorizing C.N.R. to cross with its Calgary Southerly Line twenty highways in Alberta.

15931—February 13—Approving location of Kettle Valley Ry. from mileage 28 to 52 from Hope, B.C.

15932—February 12—Authorizing C.P.R. to open for carriage of traffic portion of railway near Steel Siding, District of Thunder Bay, mileage 92 to 95, a distance of about three miles.

15933—February 13—Approving location of Algoma Central & H.B. Ry. Co.'s station at Tagona, Ont.

15934-35—February 12—Authorizing C.P.R. to construct spurs for Canadian Lumber Yards, Ltd., at Winnipeg, Man., and into premises of Crow's Nest Pass Lumber Co., Ltd., near Wardner, B.C.

15936—February 12—Authorizing C.N.O. Ry. to cross public road between Cons. 1 and 2, on Lot 8, Twp. of South Crosby, County of Leeds, Ont.

15937—February 12—Refusing application of Canadian Fraternal Association for an Order prohibiting G.T.R., G.T.P., C.N.R. and M.C.R. from collecting 25 cents from delegates attending conventions for viseing or certifying certificates of delegates.

15938—February 6—Authorizing Lachine, Jacques Cartier & Maisonneuve Ry. (G.T.R.) to cross Rachael, Hogan, Bercy and Sherbrooke Sts., in Montreal, by overhead crossings.

15939—February 12—Authorizing C.N.O. Ry. to cross eleven highways in Twp. of Markham, County of York, mileage 14.9 to 25.69 northerly from new Union Station site, Toronto, Ont.

15940—February 13—Authorizing C.N.O. Ry. to open for carriage of freight its line from Belleville to Deseronto, a distance of 16½ miles.

15941—February 3—Authorizing C.P.R. (B.C. Southern Ry.) to construct tracks of its spur from Waldo Branch to Baynes Lake across G.N. Ry. (Gateway to Fernie) at mileage 1.4 in Lot 1899, E.K.D. In Province of British Columbia semaphore protection.

15942—February 13—Authorizing N.Y.C. & H.R.R. to reconstruct bridge No. A-38 on Adirondack Division, 0.3 miles north of Athelstan.

15943—February 12—Approving location of Edmonton, Dunvegan & B.C. Ry. through Twps. 53-56, Ranges 24-26, West 4th, Alberta.

15944—February 3—15945—February 10—15946—February 3—Authorizing C.P.R. to construct industrial spur in town of Swift Current, Sask., with three sub spurs; and spur for Frontenac Breweries, Ltd., at Mile End, Que. (Montreal), and spur for D. D. Wood, city of Winnipeg, Man.

Tenders Called For

(Continued on Pages 68, 70, and 72).

CITY OF MOOSE JAW, SASK.

Sealed tenders will be received by the undersigned up to noon of Monday, March 18th, 1912, for supplying and erecting a reinforced concrete reservoir of two millions (2,000,000) gallons capacity.

Specifications and all information may be obtained from the undersigned or at the office of Walter J. Francis & Co., Consulting Engineers, Montreal.

The right is reserved to accept or reject any or all tenders.

By order of the City Commissioners.

E. B. BONNELL,
City Clerk.

Moose Jaw, Sask., February 22, 1912.

CITY OF MOOSE JAW, SASK.

Sealed tenders will be received by the undersigned up to noon of Monday, March 18th, 1912, for supplying and erecting four centrifugal pumps, two motors, wiring, switchboard and accessories.

Specifications and all information may be obtained from the undersigned or at the office of Walter J. Francis & Co., Consulting Engineers, Montreal.

The right is reserved to accept or reject any or all tenders.

By order of the City Commissioners.

E. B. BONNELL,
City Clerk.

Moose Jaw, Sask., February 22, 1912.

CITY OF MOOSE JAW, SASK.

Sealed tenders will be received by the undersigned up to noon of Monday, March 18th, 1912, for supplying various valves and fittings for waterworks installation.

Specifications and all information may be obtained from the undersigned or at the office of Walter J. Francis & Co., Consulting Engineers, Montreal.

The right is reserved to accept or reject any or all tenders.

By order of the City Commissioners,

E. B. BONNELL,
City Clerk.

Moose Jaw, Sask., February 22, 1912.

Volume 22. Toronto, February 29, 1912

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The Canadian Engineer

An Engineering Weekly

PNEUMATIC CAISSONS AT FORT WILLIAM.

By A. GILLIES, B.A.Sc.

In the construction of the foundations for the Kaministiquia River Bridge for the C.P.R. at Fort William, it was found necessary to use pneumatic caissons, in getting down to bed rock, for the two main piers.

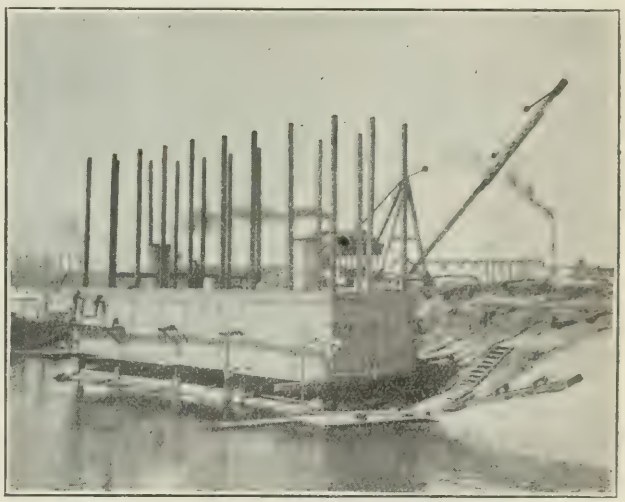
A. C. Stewart & Company have recently finished their contract for the foundation work, which proved to be a rather difficult proposition. The soundings showed bed rock at an elevation of from thirty to forty-five feet below water level, and the central piers were required to have a level bearing on solid rock.

As soon as the pneumatic caisson method was decided upon, an up-to-date air plant was at once ordered. This consisted of two Rand, Class C, air compressors, having steam cylinders 12-inch by 18-inch stroke and air cylinders 15-inch by 18-inch stroke, 515 cu. ft. each per minute at 140 R.P.M.; a 48-inch by 12 feet vertical air receiver; a water-tube aftercooler; a 50 horse-power feed-water heater; duplex

1. Caisson Under Construction.

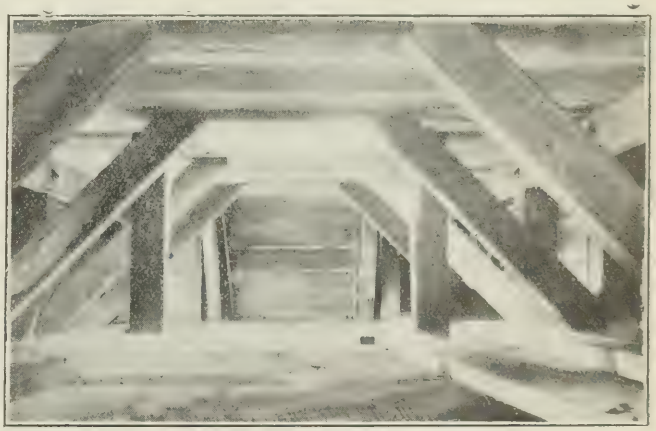
feed pumps; two duplex water supply pumps; one high pressure air compressor, steam and air cylinders 6-inch by 8-inch stroke, capacity 50 cu. ft. per minute at 195 R.P.M. with air receiver, pneumatic wood-borers and drift bolt drivers; and two 50 horse-power locomotive type boilers.

The caissons were 18 by 80 feet and built of British Columbia fir. (Fig. 1.) The walls were of 12-inch by 12-inch timber, caulked both inside and out, and planked outside with 3-inch by 12-inch vertical plank, which was also caulked. The inside posts and struts were of 12-inch by 12-inch, and the braces of 8-inch by 10-inch timber, placed at 6 feet 3-inch centres, and strengthened by 1-inch steel strut and roof rods, the roof consisted of two layers of 12-inch by 12-inch timber transverse and longitudinal; ¾-inch by 26-inch drift bolts at 36-inch centres were used in the heavy timber and ⅜-inch by 7-inch ship spikes in the plank. The working chamber was 8 feet deep and divided in the centre by a timber bulkhead of 12-inch by 12-inch timber, having 3 ft. by 4 ft. man-hole for free passage between chambers. One man-lock three feet in diameter was used and two



2. Caisson Ready to Launch.

material locks 4½ feet in diameter, of the Moon type, allowing the free passage of the bucket cable through the top doors for use in excavation of rock, etc. The working chamber of the caisson was built of 60,500 ft. B.M. of timber and 10,300 lbs. of bolts, ship spikes, etc., and had 21,800



3. Inside View of Caisson.

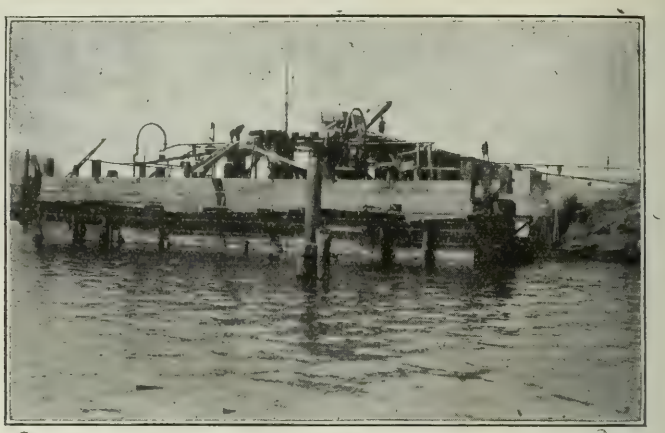
feet of caulking. The caisson was built on a skidway having a slope of 1:5. There were five skid timbers, each skid being supported by eight piles driven to hard-pan. When

the caisson was ready to launch, the supporting timbers were, one at a time, lowered down to the skid timbers which had been well greased, and the caisson allowed to slide out in a horizontal position. Before launching, the first sections of the man-lock and two material locks were bolted into position, also all pipe connections through the deck and inside fittings placed. These consisted of two 5-inch pipes with flap valves for the air; one 3-inch pipe for water connections, with valves, hose, etc., for three jets; three 4-inch pipes, with valves, hose, etc., for blow-off pipes; one connection for high pressure air; two whistle pipes; and electric lighting connections.

4. Launching Caisson.

After launching the caisson, it was towed into position and secured there by means of cables and piles. There is very little current in the river at this place, so little difficulty was met in keeping the caisson in position.

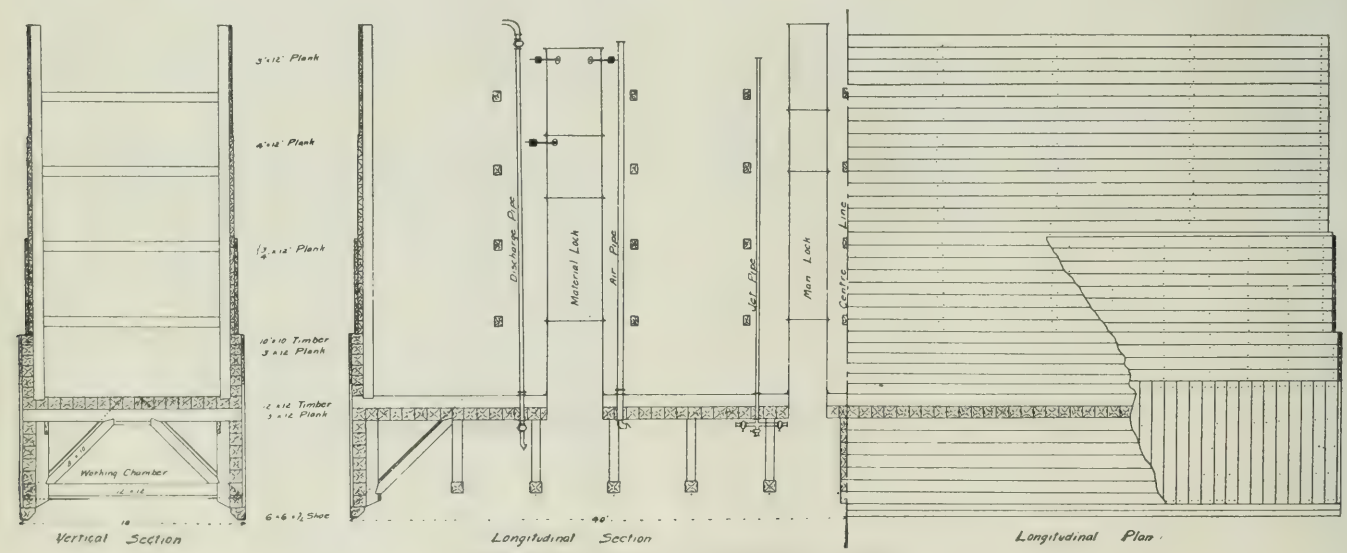
The caisson was then sunk by placing concrete on the deck, forms having first been built around the air lock shafts and piping so that they could be recovered; and the coffer dam kept well above the water level. When the shoe of the caisson was bedded in the river bottom, the air pipes were connected with the compressors and the caisson filled with compressed air. On starting operations in No. 1 caisson, the shoe was 20 feet below water level and nine pounds pressure was used. The water inside the caisson being driven out under the shoe, the air men, or "sand hogs" as they are called, entered the caisson through the man-lock; and excavation began. Three eight-hour shifts of about twenty men each were worked continuously. The air pressure and upper weight of concrete were increased as the caisson sank until, at bed rock, 38 feet down, an air pressure of 16 pounds was used. Boulders and rock were excavated in buckets through the material locks; but all clay, gravel and small stones were blown out through 4-inch pipes by the pressure within the chamber. The upper excavation was a boulder clay, the boulders ranging from small stones up to some the size of a barrel. The lower excavation was a gravelly hard-pan, also full of boulders. This had to be picked and spaded before the jets would have much effect on it, the blow-pipes were governed by 4-inch cast-iron plug-cocks which were opened



5. Sinking Caisson.

and closed as required. A ¾-inch plug-cock tapped into the pipe above this valve and left open while blowing out material, helped considerably. A 4-inch hose, 15 feet long with a 3½-inch nipple on the end, was kept with its nozzle in a pool of water formed by the jet; and the material to be excavated shoved by hand to the nozzle by the "sand hog" operating the pipe. The pressure of the air forced it up and out without the loss of very much air from the chamber.

In the hard-pan excavation, the material was taken out for from three to four feet below the shoe of the caisson but leaving a bank of material, clear around, supporting the caisson. Excavation was then suspended, and this bank was picked down to a level bench, leaving the caisson suspended by the friction on its sides. When everything was clear below the shoe, the blow-pipes were opened and the air pressure lowered three or four pounds. The weight of concrete on top was so regulated that the caisson would then



Sections and Plan of Pneumatic Caisson.

settle down on to the hard bench below the shoe. Clay was then used to "mud-up" underneath the shoe, to prevent the leakage of air; and excavation commenced again.

About 900 cubic yards of material was excavated from No. 1 caisson, including about 50 cubic yards of bed rock which had to be blasted out in one end of the caisson to get a level bearing for the pier.

When the excavation was completed, the work of concreting the caisson began. The concrete was poured on to the bottom door of the material locks and then dropped into the caisson. Wet concrete was used until the caisson was filled to within four feet of the deck. It was then sent down very dry; and benched and packed tight against the deck, leaving a narrow passage down the centre. This passage

6. Excavating Stone.

was then packed full, up to the locks and the air taken off. Six weeks was the average length of time required to excavate and concrete each caisson.

Two other caissons of the same construction were sunk for the McKellar bridge. These caissons, however, went down 45 feet and required 18 lb. pressure.

Mr. A. C. Stewart was in charge of the work; the writer was contractor's engineer; and G. N. W. Otty, B.Sc., resident engineer for the Canadian Pacific Railway.

NEW OCEAN DOCKS.

Messrs. Harland and Wolff, the famous Belfast shipbuilding firm, intend to establish ship repairing works at Liverpool.

At a meeting of the Mersey Docks and Harbor Board, it was recommended by a committee that the North dock yard at Bootle should be let to Messrs. Harland and Wolff, and the motion was adopted. The site has been taken on a sixty years' lease. It will not be necessary to construct a new dock in connection with the scheme.

Lord Pirrie, head of Harland and Wolff, is largely concerned with the White Star, American, Leyland, and Dominion lines, and with Elder Dempster and Company, Lamport and Holt, and the Pacific Steam Navigation Company, which have all been managed from Liverpool. Their tonnage aggregates over two million. The new works will employ nearly 1,000 hands.

STEAM ROLLING OF WATER-BOUND MACADAM ROADS.

General directions for the steam rolling of water-bound macadam roads are given the Road Board (Great Britain) specification No. 7. This was issued in December last, and will be of interest to all municipal and good roads engineers. We publish it in full.

1. General.—These general directions are intended for use in cases where a new surface coating is to be laid with steam-rolled water-bound macadam on any road which has a proper foundation or sub-crust of adequate thickness.

2. Trial Trenches.—Before laying the new surface the thickness of the old crust, including the foundation, should be ascertained by opening trial trenches at intervals averaging about 150 yards apart, extending from the side to the centre of the road, such trenches to be made alternately on opposite sides of the road. A careful record of the facts disclosed by these trenches should be kept, with plans and sections, for future reference.

3. If a proper foundation or sub-crust of adequate thickness does not exist, or if the road is weak at the haunches, the following steps should be taken:—

In the case of heavily trafficked roads the haunches should be strengthened and the crust thickened either with stone of any kind suitable for bottoming work, broken to a gauge of from 3 in. to 4 in., or with hard core, clinkers, or other suitable materials, according to the nature of the subsoil. In some cases, where the surface of the broken stone, after being steam-rolled, is sufficiently smooth for the purpose of traffic, it may be possible to allow the bottoming material to be used as the wearing surface of the road for a short period, not exceeding twelve months, if it is important for financial reasons to postpone for that period the laying down of the final surface coating in accordance with the other provisions contained in these general directions.

4. Total Thickness of Crust.—Even when there exists a good natural foundation, the total thickness of the road crust, including the old and the new macadam after consolidation by rolling, should not be less than 4 in. In the case of well-drained sub-soil, which cannot be materially softened by the infiltration of surface water, the total thickness, including the new consolidated surface coating as well as the sub-crust and foundations (if any), should not under ordinary circumstances be less than 5 in. In the case of fairly hard clay or other yielding sub-soils the total thickness, including foundations, should not be less than 9 in. In the case of soft wet clay or bog or marshy sub-soil, foundations of a special character may be required. (See No. 10, Appendix.)

5. Thickness of New Surface Coating.—The thickness of the new surface coating of macadam when consolidated by rolling should be from 2 in. to 3 in., according to the traffic requirements. If it is desired that the new coating should have a greater thickness than 3 in. when consolidated the stone should be applied in two coatings separately rolled.

6. Cross-fall.—The finished surface should have a cross-fall of 1 in 24, or ½ in. to the foot. If the old crust is not sufficiently thick at the crown to enable this cross-fall to be obtained when a new coating of the thickness above mentioned is super-added, the old surface should be left intact and unscarified, and the thickness of the new coating of macadam should be increased as far as may be necessary. If the crust is of ample thickness, but the cross-fall excessive, it should be reduced by scarifying the surface and removing material from the crown to the sides previous to the application of the new coating. The material so loosened by scarifying should be screened, and all material finer than ½ in. should be put on one side to be used for top dressing during rolling operations.

7. Stone and Screenings.—The road stone for the new surface coating should be stone of approved quality, broken as cubically as possible, and should contain about 70 per cent. of stone, which will pass through a 2½-in. ring, but which will not pass through a 1¾-in. ring, about 20 per cent. which will pass through a 1¾-in. ring, but which will not pass through a screen with rods ¾ in. apart. The screenings forming the residue from the above, which will be obtained by the use of the ¾ in. rod screen, should be kept separate and used as a top dressing during rolling operations.

8. Spreading.—The stone must be spread by careful men selected for their knowledge and experience of such work, as the durability and evenness of wear of the surface obtained by steam-rolled coatings greatly depends on judicious uniform spreading. The whole of the stone should be turned over in the process of spreading. Care must be taken not to allow the stone to be tipped upon the road close to the point of spreading, as this prevents a thorough turning over of the material in the act of spreading. When stones are transported by rail or by road over long distances the different sizes of stone are liable to separate themselves, and it is important that during the act of spreading they should be well mixed, so as to obviate the possibility of having larger stones on some parts of the road and smaller stones on other parts.

Note.—One ton to cover 8 to 9 square yards may be taken as an average quantity required to give a consolidated thickness of 3 in.

When stones are spread in thick coatings so that 1 ton covers less than 8 yards, there is a greater liability to unequal consolidation, inasmuch as stones are pushed in front of the roller until the roller surmounts them and thus a corrugated or wavy surface is formed.

9. Rolling.—The rolling should be carried out by a roller of a weight of about 10 tons. This must be in charge of a skilled driver who has been specially trained for the purpose. The macadam should be consolidated by starting the work at the sides and gradually working towards the centre. No water or binding should be applied until dry rolling has been carried out to a sufficient extent to form a smooth, hard surface with the correct cross-fall, with the stones well knit together, and showing their faces on the surface. The cross section of the newly rolled surface should be frequently checked by the use of a long straight-edge and level to ensure that the cross-fall of 1 in 24 is correctly obtained. No spreading or rolling is to be carried out in frosty weather. When the road cannot be entirely closed to traffic, care should be taken to minimize inconvenience to the travelling public during the progress of the work by coating one-half of the width at one time. No unrolled stone should be left on the road overnight. Care should be taken not to leave a vertical or steep edge of the new coating, but the edge should be thinned out so as to afford an easy passage from the new coating to the old surface. Notice boards warning the public that steam rolling work is in progress should be placed at reasonable distances from each end of the work.

10. Binding.—The binding material should be the best reasonably obtained. It should be either of the same material as the new coating, or of granite, lime-stone, or slag chippings, or, failing these, suitable pit gravel and the largest stone in it should not exceed ¾ in. in its greatest dimension. The binding material is not to be applied until the stones have been tightly rolled, as above described. It should then be spread, watered, and swept over the surface during the final rolling operations, working it from the channels towards the centre so as to fill the interstices or voids between the rolled stones. Care should be taken not to use more binding material or water than is absolutely necessary to ensure proper consolidation. The success of water-bound steam rolling so greatly depends on the quality and quantity of the binding material used that extreme care should be taken in its selection and application.

11. Re-rolling.—In some cases it is advisable that a steam-rolled waterbound macadam surface should be lightly watered and re-rolled from a week to a fortnight after the first rolling.

12. Records.—A careful daily record should be kept of all particulars of the work, the number of men employed, the time occupied, the quantity of material used, the area of new coating finished, and also of the state of the weather and other details.

Appendix to Road Board Specification No. 7.—In preparing for the reconstruction of roads which require a preliminary examination and reformation of contour before a steam-rolled macadam surface can be satisfactorily applied to them, attention should be given to the following points and careful records kept for future reference:

1. The relative levels of the intended road surface and that of the adjoining lands.
2. The means of disposing of surface water by drainage.
3. The nature of the fences.
4. The width of the carriageway and the full width between fences.
5. The gradients of the road.
6. The character and condition of the existing carriageway and indications of any special features of weakness or wear.
7. The cross-section of road from fence to fence.
8. The material previously used for surfacing work and most readily obtainable for road construction and the cost thereof.
9. The requirements as to foundations.
10. The points at which, on account of soft wet clay or bog or marshy sub-soil special means are to be adopted. Good results can be obtained in some cases by supporting the road crust on a layer of dry ashes or clayey gravel, or by spreading heather or faggots, but in each case the local circumstances and conditions must determine the means to be adopted.
11. Whether it is desirable to have footpaths on one or both sides of the road.

LOS ANGELES AQUEDUCT HYDRO-ELECTRIC PROJECT.

The city of Los Angeles has recently approved a bond issue amounting to $357,367 to complete the equipment of the hydro-electric project to be operated in connection with the 250-mile aqueduct by which the city water is brought from Owens Lake, near the Yosemite National Park.

The generating equipment will be installed at Power House No. 1, located at San Franciscedo, 47 miles from Los Angeles, to which point current is sent at 60,000 volts.

In the power house there will be installed three 9,375-kva., 6,600-volt, 50-cycle, three-phase water wheel generators running at 200 r.p.m.; and two 250-kw., 250-volt direct-current water wheel generators used as exciters; ten 3,150-kva., single-phase, 50-cycle oil insulated water-cooled transformers for raising the generator voltage (6,600) to that of the transmission, 60,000.

In the sub-station there will be installed nine 5,000-kva. single-phase, oil insulated water cooled transformers for stepping down the transmission voltage to either 33,000 or 16,000 for secondary distribution.

The contract for the entire equipment was awarded to the Westinghouse Electric & Manufacturing Company.

FEDERAL AID FOR GOOD ROADS.*

By Herbert J. Bowman, C.E., County Clerk and Treasurer, Berlin, Ont.

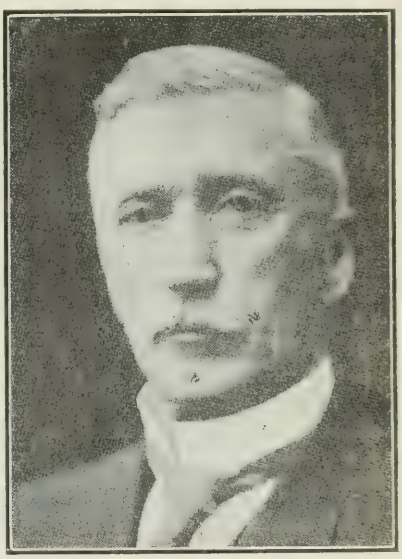
The present Dominion Government came into power committed to the policy of Federal aid for good roads. On this plank of the Halifax platform we can all stand, no matter what may be our party allegiance. In the past, the Canadian press on both sides of politics has uniformly condemned the old statute labor system. In lieu of this relic of pioneer days, a cash payment system is necessary and Federal aid for good roads will command journalistic support in all quarters and the endorsement of public bodies generally.

Raising Money for Roads.—To build good roads requires money, which must ordinarily be raised by taxation. The tax should be borne by the different sections of the community, as far as possible, according to the benefit received by each. Good roads throughout the country benefit both the producer on the land and the consumer in the city, so a portion of the cost should be levied upon the urban as well as upon the rural municipalities. Moreover, the country highways are used more and more by motor cars from the towns and cities and more expensive roads are required for this traffic. For these reasons urban municipalities should contribute towards the construction and maintenance of the highways in the adjoining rural municipalities. In the Province of Ontario, however, as now organized and administered, there is no tax on city municipalities for country roads. A remedy for this resulting injustice is supplied by Federal aid for good roads. Through it all classes will contribute towards the building of the King's highway. The splendid roads of England, France, Germany and other European countries are, as a rule, built and maintained by the national governments, under expert supervision. In the United States the Federal Government has for years maintained the Office of Public Roads in connection with the Department of Agriculture. Through this office, expert engineers are supplied free of charge and object lesson roads are built in those counties assuming county road systems. Large sums are voted by different States for building good roads, and the cities, moreover, not being separated from the counties in which they lie, contribute towards the county rates, so that there the farmers do not carry all the burden of maintaining the highways. The city of Buffalo, for instance, has already contributed towards the building of roads in Erie County over a million dollars, and pays besides, its share of the $50,000,000 voted a few years ago by the State of New York for good roads. For these reasons contributions from the Federal treasury are less necessary in the United States, and yet several bills are now before Congress for this purpose. In Canada, however, no better way can be found to defray the cost of building and maintaining roads than by annual appropriations from the surplus revenue of the Dominion.

Hon. R. L. Borden.

Grants to Provinces.—When the large delegation waited on Premier Borden on February 8th he assured us that the Dominion Government would make substantial grants to the nine provinces for highway improvement. If $1.00 per annum for every man, woman and child is given for this purpose the total sum to be voted by Parliament would be about $8,000,000. This amount could hardly be expended to advantage this year as we are not prepared as yet for such extensive operations, probably one half of this amount would be sufficient. However, if one dollar per head of population is considered a reasonable sum, it will be safe to say that $50,000,000 will be required for good roads within the next six or seven years. To divide this grant fairly between the different provinces should not be a difficult task. Some provinces have greater need of good roads than others. Where agriculture is the chief industry, improved highways are very essential, but where lumbering, mining or the fisheries are principally depended upon, the need is not so great. In the new country, branch lines of railway rather than roads are in great demand. Some of the older provinces have splendid water transportation but require improvements to canals and harbors, the deepening of river channels and other public works. By attention to the peculiar needs of each section Parliament should have no great difficulty in apportioning the good roads grant, those provinces that do not require as much money for improved highway transportation being compensated in some other way.

Effect in Ontario.—On the basis of one dollar per head of population, it would be reasonable to expect the sum of $2,000,000 per annum as our share of Federal aid for Good roads in Ontario. Half of this sum might be used to build and maintain a system of provincial highways, one great road to connect Montreal and Windsor, with branches touching all the counties to be added as soon as possible. New Ontario would continue to be developed by colonization roads as at present, but on a more extensive scale.



Hon. Frank Cochrane.

The county road systems in Ontario should receive the benefit of the balance of the Federal grant, namely, $1,000,000 per year. The provincial grant of one-third for county road work has been found to be entirely too little in the past. Federal aid will enable county roads to be built on a just basis in the future, with the burden shifted from the farmers' backs. In Massachusetts the State Highway Commission builds the roads and the county repays 25 per cent. of the cost. This generous treatment of the farmers, it should be remembered, is given by the State without Federal aid. Surely with Federal aid a certainty, we can better afford to be just to the rural municipalities in Ontario.

County Roads in Ontario.—A fair division of the cost of county roads in future would be: One-half payable by Do-

* Paper read at Ontario Good Roads Convention, Toronto, Feb. 27th, 1912.

minion; one-quarter payable by province; one-quarter payable by county. With forty counties in Old Ontario, this would mean an annual expenditure in the average county of $50,000 per year. One-quarter of this ($12,500) would be added to the county rates, or, if the county council found it necessary, this amount could be raised by debentures guaranteed by the province and sold direct to investors in the mother country instead of being peddled around to our local people at a comparatively high rate of interest.

Conclusion.—Proper supervision of this great national undertaking is absolutely necessary. Let the Dominion Government establish a Highway Commission with expert engineers to advise the provinces how to proceed and to inform Parliament of the results obtained.

Let our Ontario Government establish a Highway Commission or a department with a minister at the head of it. Then employ engineers to assist the counties in building roads adapted to their needs. This will be a simple matter in some counties, but in others it will call for the most careful consideration. Adopt as a motto for the future, "Be sure you are right, then go ahead."

NOTABLE WORK ON THE CATSKILL AQUEDUCT.

The construction work going on in connection with the carrying out of the Catskill Aqueduct project is deservedly attracting widespread attention. It is inevitable that important problems have to be solved when it is proposed to bring an enormous supply of water from a mountain district one hundred miles distant conducting it across a score of valleys some of them several miles in width, as well as across so deep and broad a river as the Hudson. The problems have especial interest for the municipal engineer because of the very character of the enterprise. They have large interest for the concrete engineer for the reason that the construction of the aqueduct is everywhere involving the use of Portland cement and concrete. The steel siphon work should have the earnest attention of the engineer and manufacturer concerned in the possibilities of steel construction. The mining engineer has his interest claimed by the shaft and tunnel construction. Portland cement (in cement mortar or in concrete) plays a most important part in all of this. It is not only involved in the concrete of the cut-and-cover sections, but it is relied on to make possible a protective covering for the inside and outside of the steel siphons. It has been found of exceedingly great value in the sinking of one of the deep working shafts; in fact, it may be questioned whether the sinking of this shaft would not have failed without it. Consider, then, the Rondout pressure tunnel and the steeel siphons.

The Rondout Pressure Tunnel.

The Catskill Aqueduct may be said, if one speaks broadly, to parallel the Hudson River. Consequently, the route cuts across the tributary streams. These are creeks or brooks of no especial importance, so far as size goes. However, they mark the positions of valleys, some of which are a number of miles in width. One of the largest is the valley of Rondout Creek In making the crossing at this point the aqueduct drops far below the surface of the ground, far below the bottom of the creek, and thus makes the 4½ mile passage from one side to the other. A vertical shaft at each end, and a third located at an intermediate point will remain permanent features. In addition, five other shafts were sunk to the tunnel grade in order to facilitate construction. One of these, Construction Shaft No. 4, is 500 feet deep. It is 10 x 22 feet in horizontal section. Eighteen months were occupied in putting down this shaft. It was flooded six times. The strata passed were:—

	Feet.
Glacial drift	6
Helderberg limestone	226
Binnewater sandstone	39
High Falls shale	92
Shawangunk grit	134
Total	497

The trouble with the water came, no doubt, almost altogether from the sandstone and the shale. But the water made its presence felt long before these strata were reached. The site of the shaft included the location where a 4-inch test-hole had been put down. When a depth of about 80 feet had been reached a sudden inrush occurred through this hole filling the shaft half full. The emergency pumping plant had not yet been delivered, so that the contractors were caught unprepared. However, by the use of an air-lift and a couple of sinking pumps the water level was lowered to a point near the bottom. A nipple was driven into the hole and casing attached to it. The purpose was to grout up the hole. In order to carry out this plan a 1-inch pipe was put down to the level of the Shawangunk grit; that is, to the 363-foot level. The water was now permitted to return. Pressures were thus equalized and currents prevented. The grout was made according to the formula 1:1 and poured down the 1-inch pipe. This latter was withdrawn as the grout filled in.

The problem of this one hole was solved in this way. But fears began to be entertained as to whether the ordinary methods of shaftsinking would prove successful. It was understood that there was below a great deal of water under considerable pressure. With subsequent events in mind, it is not difficult to see that a special pumping chamber in the side of the shaft should have been provided before permitting the excavation to pass out of the limestone. This arrangement was made later, but the delay was the source of much trouble. However, excavation went on, and the sandstone was penetrated. At the 260-foot level the amount of incoming water was only about 225 gallons per minute. However, during the drilling of the sump an additional 600 gallons per minute came in suddenly through one of the drill-holes, with the result that the shaft was flooded again. After some trouble the shaft was unwatered, only to be flooded three additional times in as many weeks. Pretty much all this water came in through bore-holes, none of which was probably over two inches in diameter. When the fifth unwatering had been completed the conditions below were known to forbid further progress apart from special precautions. In fact, it had been ascertained that large crevices were a short distance beneath the bottom of the excavation. One of the largest of these crevices was distant only a foot and a half. The size of the crevices ran up to 8 inches. As compared with the 2-inch bore-holes, they promised plenty of trouble.

Grouting up the Crevices.—It was now proposed to deal with the water question by means of grout. Four special machines were set up at the mouth of the shaft. A 2½-inch pipe led down the shaft to the bottom where a 2-inch hose carried the grout to the point of use. At the beginning of operations the grout gave trouble by leaking back. It would come in through the spaces around the pipes and through cracks in the bottom. This difficulty was successfully met by mixing finely ground hose manure with the grout. The manure produced a clogging effect. Some grout was wasted, but success was eventually obtained. In this procedure a

total of 2,900 bags of Portland cement was consumed. When the grout had hardened in the crevices a few more holes were drilled. Water having a head of 65 pounds was found 14 feet below. These holes were soon grouted up, only 60 bags of cement being required.

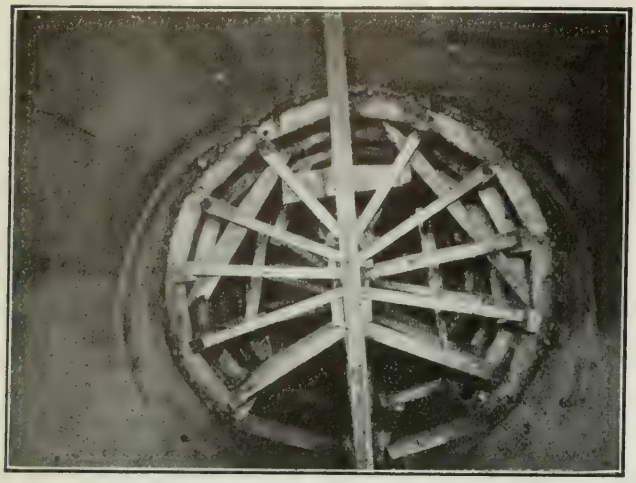
But sinking was not at once resumed. It was deemed advisable to deal further with the question of the water. The grit was now about 100 feet farther down. It was proposed to grout up the intervening water-bearing strata with more grout. Accordingly, six diamond drill-holes were put down to the grit. Half were of the size corresponding to a 1-inch core and half to a 2-inch core. With a pressure of 275 pounds per square inch, these holes were grouted up with 175 bags of cement. Nobody knew whether this small quantity of cement meant that the problem was a small one, or whether it had been only partially solved. It would seem that the thorough application of the method of grouting aheead of the excavation should have been employed sooner; that is, before the water-bearing strata had been penetrated. Sinking was now begun again, and prosecuted until a depth of 320 feet was reached. A couple of collecting rings had been arranged, and many sinking pumps installed in the shaft. The working space was much impeded. Besides, it was difficullt to secure easy, certain and adequate pumping capacity by the use of sinking pumps alone. It was determined to construct a pumping chamber off to one side at the 309-foot level. This chamber was quite large, being 10 feet high and having horizontal dimensions of 17 and 24 feet. Beneath its floor a sump, 5½ feet deep and 16 x 22 feet in area, was arranged. It had a capacity of 14,500 gallons. In the special chamber were installed three Cameron horizontal condensing pumps furnished by the Cameron Pump Works, New York City. These were all the 24 x 10 x 20-inch size, and had a combined capacity of 1,050 gallons per minute. They were run by steam supplied by three 100 horse-power boilers set up at the mouth of the shaft. As the pumps were of the condensing type, this whole arrangement was a possible one. Before the installation of this powerful pumping plant the sixth flooding of the shaft took place. Subsequently no especial difficulty was encountered from the water. More grouting was done, but none of the seams required more than 100 bags of cement, with one exception. When the grit was reached a hole gave trouble, and required 348 bags of cement. The amount of water pumped from this one shaft was 86,181,000,000 foot gallons. The total amount of Portland cement consumed in the grouting operations was 971 barrels.

Bryn Mawr Siphon—Southern End.

The Steel Siphons—Grout Inside, Concrete Outside.—Where the Catskill Aqueduct crosses a very broad valley a permanent vertical shaft is put down on each side, and the two bottoms connected by a more or less horizontal tunnel through the solid rock; but where the valleys are quite narrow, the practice is to make the crossings by means by steel tubes. These are of enormous dimensions. Three parallel tubes are required for each crossing in order to furnish full capacity. Only one is being put in at present—the middle one. There are to be, in all, fourteen steel siphon crossings of an average width of 0.455 mile. This work is divided

into two contracts, one of which is held by the T. A. Gillespie Company, of New York City.

Altogether, the fourteen siphons will require for the single central tube something over six miles of steel pipe.



Indian Brook Siphon, looking north, and showing forms in place or cement mortar lining of steel pipe. Lining is two inches thick. Invert is placed by hand on a preliminary operation,

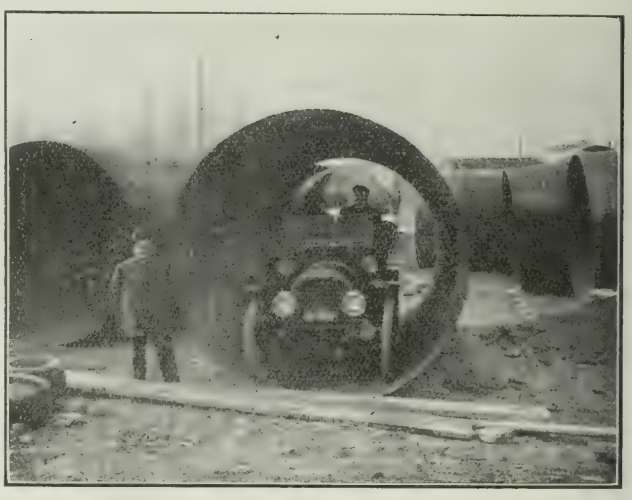
The diameters are 9.50, 9.75 and 11.25 feet. The thicknesses of the steel plates vary from 0.438 to 0.750 inch. The variations in diameter and thickness of plate are made in order to permit a standard capacity to be maintained under varying conditions, and to enable varying bursting pressures to be withstood. The joints are riveted ones. Circular joints are lap-riveted. With the thinnest plates (0.438 inch), the longitudinal seams are also lap-riveted. For plates thicker than 0.500 inch the longitudinal seams are butt-riveted. For the 0.500-inch thickness both methods are employed on longitudinal joints. The butt-riveting is done by bringing the edges together—edge to edge—and then covering the joint, inside and out, with a steel strap. The inner strap is wider than the outer one. The rivets securing the outer strap to the tube are also the central rows of rivets for the wide inner strap. They thus hold together three thicknesses of plate. In addition, two single rows of rivets are arranged outside the narrower strap, holding the tube and the inner strap together. Altogether, six rows of rivets are employed. The two central rows—one row to each side of the joint—have their rivets arranged abreast of each other. The rivets of the rows just outside of these are arranged in staggered positions relative to the two central rows. The two rows outside of all which secure only two thicknesses of plate, have their rivets placed at double the interval used in the other rows.

In crossing the Peekskill Valley over a mile and a quarter of pipe is required. All of it is of the smallest diameter. A short length (139 feet), presumably at the lowest point, is of the thickest plate (0.750 inch); then there is a total of 1,000 feet or more of the 0.688 inch thickness. Apparently no other of the crossings required such thick plate as the 0.750 inch thickness. This will be understood when it is stated that the maximum head at Peekskill is 340 feet—45 per cent. greater than in any other case. It is the widest and the deepest of the steel siphon crossings.

The steel pipe is furnished in 15-foot lengths. A circular joint has, accordingly, to be made every 15 feet. This fact has to be taken into account in the preparations for the reception of the giant tubes. Concrete cradles are arranged at such intervals as to permit the shop and field joints to come between them. The concrete cradles are eight feet or more across, measured transversely the line of the aqueduct, and about three feet wide. The same style is not used everywhere. A typical cradle has, however, a curved depression above to fit the pipe. It is then continued horizontally for a short distance. Underneath, a vertical section across the line of the aqueduct discloses a flat curve. The manner of casting is quite simple. Two bulkheads of the required form are placed on the earthen surface, which has been given the required curvature. The bulkheads are held temporarily in position by a couple of wooden strips nailed across. The concrete is poured in and the upper surface formed by hand. However, a transverse and several longitudinal grooves are desired where cradle and pipe are to come into contact. These are provided by using short lengths of wooden strips. The object of these depressions will appear later.

When the cradles have been cast, the pipe suitably placed, and the field joints made, the entire siphon is filled with water, the pressure being brought to the conditions that are to exist when the aqueduct is in actual service. This is done not merely to test for possible leaks, but especially to give the pipe the exact form it will have when in actual use. While filled thus with water the concrete envelope is put on. This is a proceeding requiring time. During this period it is important that the pressure be maintained at the required point. It is necessary, therefore, not merely to pump the pipe full, but to maintain the pressure night and day. In this and other duties Cameron pumps have been used.

It is necessary, or at least advisable, to clean the surface of the pipe thoroughly preparatory to the application of the concrete envelope. It is possible that the concrete would absorb and take care of a thin coating of rust. But no chances are being taken on that. Removable ribs are employed to hold the lagging in place. At Bryn Mawr narrow wooden strips, making lap joint with each other, were in use upon the writer's visit. The concrete is dumped upon the crest of the pipe. The jacket of concrete completely envelops the tube, except where the cradles themselves are located.



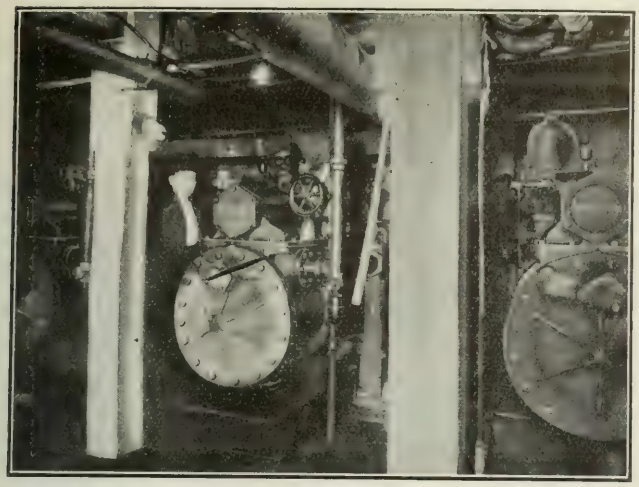
Kensico Siphon—15 ft. Section of 9 ft. 9 in. x 7-16. in. Steel Pipe. Size shown by automobile.

Prior to placing the concrete of the envelope a grout is poured into the grooves arranged on the upper surface of the cradles. Access is gained from the side. This grout fills the system of grooves beneath the steel plate and effects a close joint.

The placing of the interior shell of cement mortar is one of the most interesting and important matters connected with the steel siphon work. This lining is required to have a minimum thickness of two inches and a smooth internal

surface when finished. A little consideration will show that we have here a considerable problem. Of course, any satisfactory solution of the problem must be a commercial one. Considerable experimenting has been done.

A steel form presents, perhaps, the best surface adapted to securing the desired smoothness. It would, perhaps, be



Special pump chamber arranged to one side of shaft at depth of 300 ft. Equipped with three horizontal Cameron pumps.

difficult to provide ribs strong enough, and yet sufficiently flexible, to permit slight variations in form to be made. The tube is not a circle—it is, rather, an ellipse. A device for blowing the grout on to the steel, and thus building up the required thickness was tried for a while. It seemed to put the mortar on satisfactorily, except that it left a rough surface expensive to smooth. On the Gillespie contract wooden forms are used. The bottom of the lining is put in by hand. The remainder—about 270 degrees—is placed at a single pouring when a section of form, perhaps 20 feet long, is ready. This consists of nine segments, each covering about 30 degrees. Each segment is a unit. They are all alike, so that no mistakes can occur in arrangement. Ribs giving strength to one segmental form interlock with ribs of the next one, and so on. The interlocking is secured by providing a tongue or protuberance on one end of a rib and a corresponding notch in the other. The tongue of one rib is placed in a notch of the rib next to it around the circle. We thus get a long rib of 270 degrees. Five struts are now put in place at a number of the 270-degree ribs. These extend from a joint on one side to the joint opposite on the other. They are easily placed and easily taken down. Altogether, there are about twenty such struts used in setting one section of form. The struts contact at each end, not with the joints, but with intervening longitudinals. There is a simplicity and flexibility about this form that makes it quite successful. Metal stops are employed to regulate the distance between form and pipe. When all is ready the pouring is accomplished by means of a tube running up through the roof. This permits the cement mortar to be furnished from an outside point. The tube is arranged at one end of the form. The end selected is the lower one. A hole is left open at the other end to provide a suitable vent. No provision is made for expansion and contraction. It is assumed, perhaps, that with the pipe full of cold water and the exterior well protected there will be but a small variation in temperature.

The concrete on the outside and the cement mortar on the inside are to be considered as having no other service of importance to perform besides that of protecting the steel pipe. Time will alone tell how perfectly this has been accomplished.

CLAY TILE FREIGHT RATES.

The following information has been compiled and is issued by the Department of Physics, Ontario Agricultural College. The tables give the weight of tile and approximate freight rates in Ontario.

The railways state their traffic as so many cents per hundred-weight for a given distance, in car lots, the car to be loaded to its capacity. As the farmer wants to know the freight per 1,000 tile an effort has been made to supply this, as closely as may be. The weight of a tile of given size varies somewhat with the different makers, but those given in Table I. have been determined by actual test and may be taken as fairly representative.

Knowing the freight rate for any distance and the weight of 1,000 tile, the freight per thousand is easily worked out. The results are given in Table II.

Table I.—Approximate Weight of Tile of Various Sizes.

Size of Tile	Weight of one Tile lbs.	Weight of 1,000 Tile lbs.
3 inches	5¼	5,250
4 "	8	8,000
5 "	10½	10,500
6 "	14	14,000
7 "	18	18,000
8 "	22	22,000
10 "	27½	27,500
12 "	33	33,000

Table II.—Approximate Freight Rates of Tile.

Distance in miles	Rate per cwt.	Rates per 1,000 Tile. 3 inches	4 inches	5 inches	6 inches	8 inches	10 inches	12 inches
0—10	3 cents	$1.58	$2.40	$3.16	$ 4.20	$ 6.60	$ 8.25	$ 9.90
10—20	3½ "	1.84	2.80	3.68	4.90	7.70	9.62	11.55
20—30	4 "	2.10	3.20	4.20	5.60	8.80	11.00	13.20
30—40	4½ "	2.36	3.60	4.72	6.30	9.90	12.37	14.85
40—50	5 "	2.62	4.00	5.25	7.00	11.00	13.74	16.50
50—60	5½ "	2.88	4.40	5.76	7.70	12.10	15.11	18.15
60—70	6 "	3.14	4.80	6.30	8.40	13.20	16.50	19.80
70—80	6½ "	3.41	5.20	6.82	9.10	14.30	17.86	21.45
80—100	7 "	3.67	5.60	7.35	9.80	15.40	19.25	23.10
100—125	7½ "	3.93	6.00	7.87	10.50	16.50	20.62	24.75
125—150	8 "	4.20	6.40	8.40	11.20	17.60	22.00	26.40
150—175	8½ "	4.46	6.80	8.92	11.90	18.70	23.37	28.05

CANADIAN ROAD LAWS.

By E. A. James, B.A. Sc., Engineer for the York Highway Board.

Good roads have become a necessity in Canada, the rapid development of our agricultural districts demands good roads for the output of the farms. The work of our mineral districts necessitates good roads from the mines to the railway station or to the steamboat wharves. The day of the horse drawn freighter is almost gone and the demand now is for roads that will withstand the traffic of vehicles propelled by motor power.

The demand for good roads in Canada is more than necessary, it is imperative.

There are approximately 26,650 miles of steam and electric railroads in Canada to-day. No one knows exactly how many miles of highways there are, but most careful calculation one can make will place it at 1,010,000 miles.

Before taking up the question of building of good roads we would present a resume of the road laws of the various provinces of Canada.

It is necessary that the highway engineer, who has to give one-half of his time to administration work, should know the leading features of road system laws as it is, that he should know the main points in road building.

Good roads may be built under many systems of organizations and control and different systems under different conditions may give equally good results, however, the engineer must be informed on the various systems, so that he may select the best for the condition in which he is working.

The engineer is not a legislator, but he is frequently consulted when legislation is framed, therefore a study of Canadian legislation dealing with Canadian roads is naturally of interest to highways engineers.

Canadian Highway Act.—The most recent and most important legislation dealing with highways in Canada is bill 77, introduced in the House of Commons, Ottawa, by the Hon. Frank Cochrane, Minister of Public Works, in January of this year.

It is entitled: An act to encourage and assist the improvement of Highways, and although it has not yet become law, still it is of such importance that we give the full text of the bill.

> **Bill 77.**—Whereas the highways of Canada constitute an important part of the facilities which are necessary for any efficient national scheme of transportation and inter-communication; and, whereas, with the increasing progress and development of the country it is desirable and expedient to improve and extend the existing highway facilities, and for that purpose to give assistance to the various provinces of Canada: Therefore, his Majesty, by and with the consent of the Senate and House of Commons of Canada, enacts as follows:
>
> 1. This Act may be cited as The Canada Highways Improvement Act.
>
> 2. In this Act the word "Minister" means the Minister of Railways and Canals.
>
> 3. The Governor-in-Council may, in any year, and upon such terms and subject to such conditions as are prescribed by Order-in-Council, grant to any province in aid of the improvement of existing highways or the construction of new highways in such province, or for both such purposes, a subsidy not exceeding such sum as may in such year be voted by Parliament for that purpose.
>
> 4. Any highway for which aid is granted to a province shall be improved or constructed, as the case may be, according to descriptions, conditions, and specifications approved by the Governor-in-Council on the report of the Minister, and specified in each case in an agreement between the Minister and the Government of the province, which agreement the Minister, with the approval of the Governor-in-Council, is hereby empowered to make.
>
> 5. Each highway to be constructed or improved shall be defined and described in such agreement, and provision may be made therein for the future maintenance of such highway in good condition according to a specified standard, and to the satisfaction of the Governor-in-Council.
>
> 6. The Minister, with the approval of the Governor-in-Council, and upon such terms and conditions as are prescribed by Order-in-Council, may undertake the construction of any new highway or the improvement of any existing highway in any province, and may expend in such improvement or construction the whole or any part of the sums voted by Parliament, for such subsidy to that province. Provided, however, that the Minister shall first obtain the necessary authority from the Legislature of such province and the consent of the Lieutenant-Governor-in-Council.

This measure is the first step by the Dominion Government to give aid for the building of the King's highway. Since Confederation the Dominion Government has granted eighty million dollars to build and improve our railways and eighty-eight million two hundred thousand dollars (exclusive of G.T.P.) to construct our canals, but not one cent for highways. With a Canadian Act granting aid to highways, new interest will be taken in the subject and a new impetus given to road-building

Provincial Road Laws.—Each province has its own road law and, as might be expected, the laws vary with the provinces, as the conditions peculiar to those districts warrant.

Prince Edward Island.—Prince Edward Island, with the exception of the city of Charlottetown, and the town of Summerside, has no municipal government of any kind; however, the highways of the province have been placed entirely under the Department of Public Works. For the purposes of administration, the province is divided, by the department, into thirty-eight road divisions, each containing about 100 miles of road. These divisions are under road inspectors, who have a certain amount of machinery under their control to be used on this section. The general soil of Prince Edward Island is of a soft, loamy character, and about 90 per cent. of the roads are earth roads. During 1910 there was spent on the highways about $32,000, or a little over $8.00 a mile.

The Public Road Act of this province, as amended in 1910, contains a clause which provides for tax of $1.00 per head per annum upon all persons between the age of twenty-one and sixty except clergymen and overseers, and a tax of 25 cents per head per annum upon all horses over three years of age, except those used by clergymen and overseers.

During this year a Good Road Association has been formed, and it is expected that the following educational campaign work of constructing permanent highways throughout the provinces will shortly be undertaken.

Nova Scotia.—In the province of Nova Scotia the roads are under the control of the municipalities who have direct control of the statute labor.

The Provincial Government, however, make expenditure upon these highways, dividing their expenditure into two accounts.

(a) Contribution to bridges costing more than $500.00 to construct.

(b) Expenditure on the construction and maintenance of highways constructed by the municipalities under direction of the commissioner of roads.

The municipal councils have no control over the expenditure of these moneys, as all charges are paid from the provincial treasury.

An amount of about $250,000 is assessed by the municipalities under the statute labor law, and the work is carried on under the control of these authorities.

Yearly reports, showing the amount collected or uncollected in each district, are submitted to the road commissioner, and by him to the government, but outside of the regulations of the statute labor law, the government exercises no jurisdiction with regard to statute labor, as this law was enacted after consultation with the wardens of the various counties.

It is proposed to borrow money on capital account and to expend it under the same system as that of larger bridges, that is, under some authority appointed by the government. This is to supplement the present expenditure from revenue which, with 18,000 miles of road to keep up, is insufficient to do more than make the roads passable and to attend to the most urgent cases of reconstruction or the building of new roads.

In 1880 the municipalities had full control of the roads and bridges, but neglected the same, and the government enacted various laws, first, taking over the construction of larger bridges, and secondly, the repair of same; then, thirdly, the construction and repair of smaller bridges, and fourthly, the maintenance of public highways to a great extent.

The expenditure for roads and all structures connected therewith, not included in the foregoing, arising from two sources:

(a) Government grant.

(b) Statute Labor.

The control of the government grant is placed in the hands of a road commissioner appointed by the government, and is apportioned into sums required for the painting and repairs of larger bridges for the construction and repairs of other structures, for the purchasing of road machinery, and according to a scale approved by the government for any construction and repairs of highways in the different municipalities of the province.

The statute labor is entirely in the hands of the municipal councils, and is also expended on the construction and maintenance of the highways, there being a working arrangement between the municipalities and the commissioner of roads in the localities in which the work is performed.

Ontario.—The roads of Ontario in the newer sections are under the control of the Department of Public Works, and are known as colonization roads. When the districts become organized the roads come under the control of the township councils. Township councils have full control of these highways and they maintain them either by statute labor or direct taxation.

In some counties certain roads have been set apart as leading highways, and come under the Highway Improvement Act of Ontario. Under this Act provision has been made that where certain roads are set apart and approved of by the government on being constructed according to the specifications submitted by the province, the province will pay one-third of the cost. So far the department have taken the stand that a grant will only be made to county systems.

Alberta.—Alberta has not yet been divided into rural municipalities, but it is expected that at the present session of the Legislature a Municipality Act will be passed giving rural municipalities control of the highways. Up to the present the Public Works Department of Alberta has had charge of road improvement works.

Where portions of the country are organized into Local Improvement Districts (which is the first step towards municipalities) the Provincial Government frequently makes an expenditure, conditional upon an equal amount being paid by the Local Improvement District, and practically always insisting upon supervision by their engineer, inspector, or general road foreman, as the case may be.

All highway bridges so far in the province of Alberta have been constructed by the government.

Saskatchewan.—The rural highways of Saskatchewan, in settled districts, are under local improvement boards, which usually represent a district of four townships.

In the newer districts roads are under the control of Department of Public Works, and for the construction and maintenance of these roads the government levy a tax of $2.00 per quarter section.

To supplement this sum the government vote a special grant annually, which amounts to approximately a three-quarters of a million dollars. Where the municipality undertakes improvement work which has been sanctioned by the Department of Public Works, the government will pay a subsidy of 25 per cent., provided not more than $1,000.00 is spent in any one year to any one road, and providing that not more than two roads in any municipality receive a grant during the current year.

British Columbia.—In the early days of this province road building was undertaken by military engineers. Later the Department of Public Works undertook the management of the highways and provincial roads are now the main traffic arteries of the provinces.

In road building British Columbia has the advantage of good material with which to build and centralize authority to undertake the work. Five million a year for the next three years is the sum they anticipate spending on highways.

Outside of the towns and cities the roads are largely provincial highways.

CONSISTENCY OF CONCRETE.

A circular letter of inquiry on the subject of the Consistency of Concrete was addressed to the members of the Concrete Institute of Great Britain, in which it was suggested that a specification as drafted would be of service, pending experiments and tests that ought to be made to determine the exact proportion of water to be used in concrete in order to obtain the best mixture. This specification, as now slightly modified by the committee, is as follows:—

Consistency of Concrete.—For mass concrete the quantity of water added to the other constituents shall be sufficient to make a plastic mixture which, after thorough ramming, will quiver like a jelly.

For reinforced concrete the quantity of water added to the other constituents shall be such that the plastic mixture is capable of being rammed into all parts of the moulds and between the bars of the reinforcement.

Note.—In dry or hot weather the quantity of water shall be increased in order to allow for evaporation.

Fifty-eight replies were received, which have been carefully considered by the Reinforced Concrete Practice Standing Committee, who have come to the following conclusions:

1. It is inadvisable to lay down any definite rule as to the percentage of water to be used in mixing concrete, owing

to the varying conditions which obtain. The proposed specification is difficult to improve upon, and seems to meet with general agreement.

2. The strength of concrete apart from any reinforcement increases as the amount of water used in mixing is decreased, this being more particularly the case during the earlier stages of the maturing of the concrete. Eventually the wetter of two mixtures will approach more nearly to the drier in strength.

3. In reinforced concrete, particularly in such portions as may contain a large amount of reinforcing bars or the like placed closely together, it is essential that the concrete should be sufficiently wet to pass between the reinforcing bars, and to thoroughly surround every portion of the steel. This should be ensured even at the expense of having the concrete wetter than would otherwise be desirable.

Where the reinforcement is not very closely spaced it is unnecessary for the concrete to be so wet.

4. Other conditions being the same, the drier the concrete the more quickly will it set and mature. This is of importance when there is any danger of green concrete being attacked by frost.

5. The wetter the concrete the greater is the tendency to contract during the process of setting and maturing. Appreciable contraction may sometimes continue for a period of several years.

6. The committee is divided as to the advisability of determining by some means of mechanical test the exact degree of "wetness" or consistency of concrete after mixing. If some scale of consistency were adopted, it would be possible to specify that concrete for any particular portion of the work should be of such and such a consistency, after mixing. This would not, of course, be at all the same as specifying that any particular amount of water should be used in mixing such concrete owing to differences of atmospheric temperature, aggregate, &c.

The advocates of the institution of some such scale of consistency are of opinion that the Concrete Institute should carry out tests on the subject.

DEFINITION OF ELASTIC LIMIT.

The Engineering Standards Committee of Great Britain gives standard definitions of the terms "yield point" and "elastic limit." The former, specified as "the point where the extension of the bar increases without increase of load," is defined as follows: "The yield point is the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers or at which when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger." To this is appended this note: "A steel test piece at the yield point takes rapidly a large increase of extension amounting to more than 1-200th of the gauge length. The point is strongly marked in a stress-strain diagram." The Elastic Limit is defined as "the point at which the extensions cease to be proportional to the loads. In a stress-strain diagram plotted to a large scale it is the point where the diagram ceases to be a straight line and becomes curved," and it is added that "the Elastic Limit can only be determined by the skilful use of very delicate instruments and by the measurement of the extensions for small successive increments of load. It is impossible to determine it in ordinary commercial testing." In a note added by request of the Ships Committee, it is remarked that the committee does not recommend the use of either "Yield Point" or "Elastic Limit" in the standard specifications for ship material, because in regard to the ascertainment of the Yield Point there is considerable divergence of opinion as to the best method of determining it, and all methods involve greater time and care than can be expected in the works. While it is possible in works by careful testing at a greatly reduced speed to obtain the Yield Point in ordinary mild steel and wrought iron, some of the harder steels and other constructional materials have no definite Yield Point at all, and some have no Elastic Limit. Further, it is quite impossible to determine the Elastic Limit in the time available for ordinary commercial testing. In its determination a specially delicate and accurate extensometer must be used, in the hands of a careful and competent observer, and the determination for each test bar would require a considerable time. It is properly a matter to be left to laboratories organized for scientific purposes. The Ships Committee is therefore of opinion that the present method of fixing, by experience, the working stress for any material as a proportion of the ultimate breaking stress, rather than as a proportion of the Elastic Limit or Yield Point, is the best practical method, and it considers that the inclusion in the British Standard Specifications for ship material of tests to ascertain either the Elastic Limit or the Yield Point would not justify the dislocation of the ordinary commercial testing as carried out in the works' test rooms which would thereby be entailed.

STEAM POWER PLANTS.

At the recent convention of the Coal Mining Institute of America, held in Pittsburg, December 19, there was read a paper on "Steam Power Plants," prepared jointly by O. S. Lyford, Jr., consulting engineer, and R. W. Stovel, mechanical engineer, Westinghouse, Church, Kerr Company. The paper read in part as follows:

"Owing to the diversity of fuels used in steam power plants in various sections of the country and the difficulties to be encountered in making comparisons of the values of the different fuels, we have taken Pittsburg coal with a thermal efficiency of 14,000 B.t.u. per pound as a standard for the calculations made.

"As to power plants, the ideal plant would be one that could be planned and made up in the shop, taken down and erected where it was required, but unfortunately this system of building power plants is impracticable from the fact that each plant has its peculiarities and offers different conditions to be met with so that it is very rarely that the same plans would answer for two different plants. As there are power plants for a great variety of purposes, we have, to simplify matters, considered only electric plants for railways and power stations, operated by steam turbines and where bituminous coal is used as fuel. Ten plants of this type have been selected ranging in capacity from 79,000 down to 1,000 kw., located in various parts of the country and operated under a variety of conditions."

Views were shown of foundation plans, floor plans, sectional, exterior and interior views of various plants. From the costs of constructing these plants the authors of the paper had prepared a table giving the maximum and minimum costs of each item of importance entering into the erection and equipment of the plants and the totals showed that the costs ranged from $38 to $83.75 per kw. The cost of boiler installations ranged from $23.15 to $50.25 per horse-power.

"It will be seen that the fuel to be used has been decided, the geographical location of a plant has little to do with the design or equipment, but that the location of the water supply and the method of receiving fuel are important facors; also that a proper design and proper arrangement of the apparatus have more to do with the cost of the plant than any other factor."

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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HIGH BUILDINGS.

In a recent newspaper report we note that Winnipeg is to have a fifteen-story building. The larger cities in Canada have come to the stage where they must settle their policy with respect to high buildings. At the present time there is little or no restriction of height, and, to our mind, that is a very serious condition.

High buildings tend to cause congestion of traffic, and, while in some cases, such as New York, they are necessary, we doubt very much as to the necessity in Winnipeg. Here the city has plenty of chance to expand and develop, and there is no immediate necessity for very high buildings. The present building by-law in Toronto limits the height to 100 feet above the curb line, except in the case of buildings higher than this, when they must be passed by both the City Architect and the City Council. The city of Montreal has always restricted the height to 130 feet and ten stories above the sidewalk level of the principal front. The committee there, who are now revising these by-laws, propose to keep to the 130 feet, but they may permit eleven stories. Boston keeps within the 130 foot limit. Quebec has no building height restrictions whatever, and the reason for this is that up to the present time there has probably been no necessity for one.

The recent terrible disasters which have overtaken Baltimore, San Francisco, and some of the other American cities has shown the danger of concentration of a number of people in a small area.

The development of fire-breaks prevents the very extensive spread of fire in the congested districts, and the development of sprinkler devices, both inside and outside the building, have aided in protecting individual buildings.

At the same time, it remains an absolute fact that a fire occurring in these very high office buildings is a fearful menace to the inmates. With the increased height comes increased danger, and we believe that modern civilized communities are beginning to appreciate this fact. The only way to safeguard the danger, or at least to minimize it, is to limit the height.

In an address to the Montreal Builders' Exchange Mr. Walter J. Francis, the engineering expert on the Montreal City Building By-laws Committee, said that in his opinion the iron fire escapes on the outside of buildings are a very much over-rated device. These escapes, he said, generally open from windows, through which, in case of fire, smoke and flames are pouring, making the escape-bars red hot like furnace grates.

Aside from the fire danger, there are many other disadvantages from the use of high buildings. Mr. Ernest Flagg, a New York architect, in a recent interview drew attention to some of the abuses flowing from the use of sky scrapers. Mr. Flagg states that in the use of very high buildings the owner perpetrates a serious wrong on his neighbors in depriving them of light. He draws attention to the fact that in many cases the use of high buildings is not only justified, but required. The street plan, however, should be modified by widening. If we double the height of a building we should double the width of streets in order to provide light and the capacity for handling the traffic of the street. He also

lays emphasis on the innate ugliness of the sky scraper, and the difficulty of providing æsthetic treatment in its use. Mr. Flagg states that very often these buildings are a monument of individual or local vanity.

Our cities in Canada are comparatively young, and there seems little reason why high buildings should be allowed now, if adequate transportation facilities in the shape of well-laid-out streets are made. The consequent danger from fire with high buildings is far too serious to allow us to enter on this without first exhausting every other means for the easy handling of business and interchange of traffic.

THE ONTARIO GOOD ROADS ASSOCIATION.

The Ontario Good Roads Association met this week in Toronto. Mayor Geary extended a civic welcome on Monday morning to delegates from all parts of Ontario. It is easy to see the increased interest that is being taken in the good roads question throughout the province by the numbers in attendance at the Convention and the interest taken in the papers read and the discussions thereon.

The Ontario farmer is beginning to appreciate the advantages which will be his from a good system of highways connecting all parts of the province and allowing of easy traffic and intercourse. President Kennedy, in his annual address, expressed gratification that the federal and provincial Governments had recognized the necessity of helping to shoulder the burden of constructing and maintaining the highways. He referred to the vast sums which had been granted as bonuses for railway construction, and said that it was now time for bonuses to the highways system.

Mr. Kennedy stated that in his opinion the clause in the bill now before the Dominion Government, which allows the Federal Government to build roads in the province, is a mistake. He said: "The federal highway is only a trunk road; it would not reach the individual. What Ontario wants, especially the farmer, is a provincial system of main highways reaching from county town to county town. Such a system would comprise nearly 2,500 miles."

In our opinion Mr. Kennedy is right, for there will certainly be difficulty in administering that clause of the bill which states that the Minister, with the approval of the Governor-in-Council, may undertake the construction of any new highway or the improvement of any existing highway in any province, and may expend on such improvement or construction the whole or any part of the sums voted by parliament for such subsidy to that province. There is a qualifying clause in the bill which states that the Minister shall first obtain the necessary authority from the legislature of such province and the consent of the Lieutenant-Governor-in-Council.

The administration of these funds must be more closely brought under the control of the several provinces, while the administration, experimental work and general organization of the good roads question should be placed in the hands of a Dominion Good Roads Department.

EDITORIAL COMMENT.

Among the letters written to the Editor as a result of the recent editorial on the "Employment of Engineers," the following ideas predominate: In all work of a public nature the best man should be secured for the position. In many cases where foreign expert advice has been secured it would have been found, if a close examination had been made, that the best advice could have been obtained from a Canadian. We are rather inclined at times in this country to underrate the capabilities of our own people; in other words, "the prophet in his own country."

* * * *

The Department of Industrial Research of the University of Pittsburg, is entering upon the study of the smoke problem in the broadest possible manner. The Department is taking as the chief lines of investigation the effect of smoke on health, plant life and buildings. The increased cost of living, due to damage and dirt caused by smoke, and the legal, as well as the engineering side of the question, are also to be considered. Each of these investigations will be carried on by one or more men, each a specialist in his line. The Department hopes that by co-ordinating these various researches it will be possible to obtain valuable technical as well as scientific data. They will, at least, be able to establish the status of the problem on a scientific basis. The University of Pittsburg are to be congratulated on the attitude they have taken in this matter. If our Canadian universities, through their Applied Science Departments, would devote more time to the chemical, industrial and manufacturing problems throughout the country, in place of fostering the theoretic side of pure science to the neglect of the practical, they would be doing more towards deserving private and government aid.

CORRECTION.

In our issue of February 15th we published an article, entitled "Underground Street Construction," and neglected to credit our contemporary, "Good Roads." We are glad at this time to correct the omission.

TORONTO BOARD OF TRADE.

An important address was delivered recently by Mr. R. S. Gourlay, retiring president of the Toronto Board of Trade, at the annual meeting. It reviewed at length the work of the year and was characteristic for its broadminded tone. Among the important matters before the Board during 1911 was the proposal to enlarge and deepen the Welland Canal. An impetus had been given to the agitation started four years ago by the improvement of the Erie Canal in the State of New York at a cost of $100,000,000. The work of the board in 1910 made the deepening of the Welland Canal more than a by-word. It became an important issue before the Government, and disappointment was felt when the estimates for 1911 did not include an appropriation for the commencement of the enterprise. The project also had the endorsement of the Associated Boards of Trade of Ontario.

THE PRINCIPLES OF SPECIFICATION AND AGREEMENT WRITING.

By C. R. Young, A.M. Can. Soc. C.E.

(Registered in accordance with the Copyright Act.)

Third Article.

SUBJECT-MATTER OF THE SPECIFICATIONS.

Because of their content, the clauses of the specifications fall naturally into two classes—Specific and General. In the former are treated all those matters referring to the extent, character and details of the work, while the latter concern the authority, privileges and procedure of the parties or their representatives in office and field. In order of development the specific clauses come first, for on them the major portion of the time given to the preparation of the specifications must be spent. It is often possible to adopt general clauses from previous specifications with little alteration, but the specific clauses must generally be specially prepared for each piece of work, due to the changed conditions and types of construction.

SPECIFIC CLAUSES.

Among the most important matters to be covered in the specific clauses of the specifications for a typical piece of construction work are the following:—

(1) Extent of the Work.
(2) Dimensions and Proportions.
(3) Accompanying and Contemplated Drawings.
(4) Capacity or Required Performance.
(5) Designing Rules.
(6) Classification and Estimating Rules.
(7) Quality of Materials.
(8) Quality of Workmanship.
(9) Methods of Construction.
(10) Inspection.
(11) Condition of Finished Work.
(12) Acceptance Tests.
(13) Cleaning up.

The order to be pursued in the writing of a specification is not necessarily that outlined above, nor would these matters be wholly treated in individual sections under the foregoing captions. For example, the required character of the cement, concrete, brick, stone, timber and steel for a piece of work would not ordinarily be completely covered in one section, entitled "Quality of Materials," but rather under headings denoting the class of construction, as "Concrete Work," "Brick Work," "Stone Work," "Carpentry," and "Structural Steel." By this means the specification is divided up into portions corresponding to the various trades or constructional interests affected—a proceeding which greatly facilitates the preparation of bids by contractors.

(1) **Extent of the Work.**—In the interests of convenience and in furtherance of accuracy in bidding, the amount of the work to be done should be described both as a whole and in detail.

The portion containing the description of the work as a whole is probably the most important single clause in the specification, and generally it is the first of the specific clauses. In it is given a concise and clear statement of the extent and scope of the work, from which the Contractor is able, not only to decide whether it is worth his while to bid, but to roughly check his total estimate and ascertain if all the important operations and the principal quantities have been provided for. This clause should, therefore, contain the following information:—

(a) An enumeration of all the important steps or operations involved in the work:—

(b) Mention of any portion of the work to be performed by the Owner or by another Contractor, or any materials to be supplied by these parties.

(c) A statement of quantities, if practicable.

The following clause, from a slightly-altered contract covering the construction of both the substructure and the superstructure of a steel bridge, is typical of the method of describing the work as a whole where a statement of quantities is not given:—

> "The work comprised in this Contract will include taking down the old superstructure and abutments; neatly piling the old material at the side of the road near the bridge in such a manner as not to obstruct traffic; erecting and maintaining a temporary bridge, utilizing the material from the old bridge in so far as practicable; excavating materials to the depth required for foundation beds; filling in the excavated spaces around the abutments up to the original ground level; the construction of two concrete abutments; making earth approach fills behind the abutments; placing a gravel surface upon this filling; procuring, fabricating and erecting a steel superstructure of thirty (30) feet clear span on the completed abutments; constructing a reinforced concrete floor after the steel superstructure has been erected; removing all falsework, surplus material and débris from the site of the work and leaving the structure complete and ready for traffic."

In general, the embodiment of a schedule of quantities in the description of the work as a whole is to be desired. It is of especial assistance to the Contractor where the project is of considerable extent or where many different classes of work are covered in the contract. The waste of time and effort involved in requiring every bidder to compute the plan quantities is most regrettable. These calculations should be made by the engineer, and the responsibility for their accuracy should be assumed by him quite as much as the responsibility for computations of distances, stresses or sections.

The extent of each kind of work should also be described in detail in a section of the specification devoted to that purpose. Detail should, of course, be excluded from the description of the work as a whole, since the value of that portion of the specification largely depends upon its conciseness. An illustration of a detailed provision fixing the extent of a particular kind of work would be the following abridged clause from a contract for the construction of a sewer:—

> "The ground on the line of the proposed sewer is to be excavated in open cutting. . . . the depth of the bottom of such excavation being in all cases as shown on the profile, or as laid down by the Engineer, as he may think necessary to secure a firm foundation and proper level. . . . For pipe sewers the cutting at the bottom is to be at least eight (8) inches wider than the pipe to allow the haunches to be well packed and rammed with suitable tamping irons."

Where several classes of work of a similar character occur in a piece of construction the limits of these classes should be carefully defined, as the lines of demarcation

of concrete of different mixtures in the same structure. This may be done by stating the elevations of the top and bottom faces of each class or by mentioning the various portions of the structure in which a given class is to be used.

In most contracts there are operations to be performed and material to be supplied for which the Contractor receives his compensation in the prices for other work. Thus, embankment work and back-filling are commonly paid for in the prices for excavation. The remuneration for sheet-piling, cofferdamming, pumping and baling is received in the prices for excavation or masonry. Falsework, forms and staging are covered in the price for the permanent work, whether it be steel, concrete or masonry. Obviously, therefore, the contract should indicate such of these items as may be paid for directly and such as are covered by prices for a different class of work. For all those paid for in the first manner, prices should be set down in the agreement, and those covered in the second way should be so described in the specific clauses of the specifications.

It is particularly desirable that each kind of work for which a price is named in the agreement should be clearly described in a paragraph of the specifications. The applicability of these prices to any particular work in question may thus be readily judged, and numerous disputes over extras thereby obviated.

(2) **Dimensions and Proportions.**—There are many facts of a dimensional nature which it is not convenient to put on the plans, and which, because of their amenability to written descriptions, are inserted in the specifications. In grading contracts, it is very common to specify in writing the width of cutting and embankment and the side slopes in both cuts and fills. The engineer who prepares a general specification for a bridge without accompanying plans, sets forth the required clear span, clear width of roadway, clearance above the bridge floor, and, for the abutment and pier heights, the clearance above some specified water level. Certain limiting sizes or sections for main material, and also for details, are commonly established in any structural specification. The municipal engineer specifies a certain minimum relation of the width of a sewer trench to the internal horizontal diameter of the sewer.

(3) **Accompanying and Contemplated Drawings.**—For purposes of identification, and also for ease of reference, a list of the accompanying drawings is incorporated in the contract. Preferably it is placed in the specifications rather than in the agreement. If either the Owner or the Contractor is to prepare future detail drawings for use in the construction of the work, this fact should be stated, and the stipulation made that no work based upon such drwaings is to be executed until they have been approved by the engineer. While the inclusion of future illustrative or detail drawings in a contract is permissible and consistent with the legal requirements, it is not allowable to include drawings establishing principal or primary features unless such drawings are in existence at the time of signing of the contract.

In the section devoted to drawings it is customary to state that figured dimensions are to be given precedence over scaled ones, except in case of obvious clerical error, when the one most consistent with the contract as a whole is to be adopted.

(4) **Capacity or Required Performance.**—Specifications for most engineering work set forth some particular performance of which the construction must be capable. If it be a bridge, building or analogous structure, it must safely accommodate certain superimposed loads, and frequently this must be done without exceeding a specified deflection. In addition to this the structure must be able to resist at the same time the stresses brought to bear upon it by impact, wind, traction and temperature changes. If the contract concerns a pumping engine, the latter is required to pump so many gallons of water per pound of dry steam or per one hundred pounds of coal. A generator must have an output of so many kilowatts, and be able to carry a stated overload without a rise of temperature of over a certain number of degrees. For certain kinds of construction, as pavements and sidewalks, it is frequently required that the work shall show a specified endurance against wear, or resist the various destructive agencies brought to bear upon it for a stated term of years without abnormal deterioration.

(5) **Designing Rules.**—Where the work is to be designed by the Contractor on the basis of general data submitted by the engineer, comprehensive designing rules must be inserted in the specifications. Even when the work is designed by the engineer himself, and only the details are worked out by the Contractor, it is necessary to include certain of such rules for the guidance of the Contractor in designing the details.

The stipulations respecting design may be conveniently divided into three classes: (a) Assumptions of design, (b) permissible stresses, and (c) approved details. The assumptions of design include such matters as effective spans of beams, girders, floor-beams and trusses; effective depth of plate girders and reinforced concrete T-beams; maximum allowable slenderness ratio for columns; width of slab to be counted as flange in a T-beam, and many other matters of the kind. Under permissible stresses are set forth the intensities of tensile, compressive, bending, shearing, bearing and torsion stresses, or combinations of them, which must not be exceeded for the various materials to be employed in the work. In order that objectionable details may be obviated, the engineer should be careful to fix by the specification the character of the details desired, in so far as it is possible to do so. It is, therefore, common to specify such matters as that plate girder flanges shall be made up of a certain minimum percentage of area in the angles; that compression chords shall be of box rather than T-section; that rockers or bolsters shall be used for the bearings for all spans over a certain length; that reinforcement steel shall be spaced, lapped or spliced in a certain manner; that the lower ends of longitudinal rods in reinforced concrete columns shall rest on bearing plates, and many other analogous requirements respecting details.

FOREST FIRE WASTE.

An important phase of Canada's fire waste was discussed by Mr. Percy Robertson, insurance broker and fire prevention engineer, at a recent meeting of the Toronto Insurance Institute. His address was illustrated with stereopticon views.

As an illustration of the extent of past losses by fire in our forests, he referred to estimates made by the Dominion one-half of the original timber supply has already been destroyed by fire; that government stumpage dues at the moderate rate of 50c per 1,000 feet on the timber destroyed would have yielded a revenue of $1,000,000,000; and that for every foot of timber ever cut in Canada, seven have been destroyed by fire. Serious forest fires continue to occur, and such a state of affairs demands the adoption of vigorous and intelligent preventive measures.

COUNTY ROAD CONSTRUCTION IN ONTARIO.*

By W. A. McLean, Provincial Engineer of Highways, Ontario.

Canadians are universally proud of their country, and of its resources of mine, forest and field. The possession of such a splendid land carries with it certain obligations to do as our forefathers have done, to make and leave it a better place to live in than we found it. A tremendous energy is now being exerted to develop Canada, and one of the striking phases is in relation to agriculture, in which, more and more, improvement is being sought, and the farmers of the country have entered upon what we trust may be a long period of advancement and prosperity.

To aid in the development of Canada one of the larger enterprises has been the construction of steam railways. Over 25,000 miles have been built, and the capital invested exceeds 1,500 millions. So intent have the Canadian people been upon securing railway facilities, that land and cash subsidies and other aid have been granted by the Federal and Provincial Governments, and municipal corporations, amounting in value to about 600 millions; or nearly one-half the capital investment in railway construction.

Railway construction has been supplemented by canals, harbors and steamship lines so that, at a very large cost, the people of Canada have generously provided for an important section of the transportation problem. Having great resources, and having magnificent railway and waterway facilities, we are still very much like the man who had a wagon and a team of horses, but was without harness; and so neither wagon nor horses were of any use. The need of Ontario and of Canada to-day, is a system of good roads that will harness our railway and waterway team to the farm, whereby both the farm and the greater transportation systems will attain their full value and usefulness.

At the present time the roads of Ontario are largely maintained by the townships with statute labor, while important construction is being carried on by county councils. Proposals of Federal aid suggest that the road organization of the Province may be broadened out so as to include three classes, township, county, and state, on a basis such as has created the good roads systems of older countries and of a number of the American States.

The actual building of good roads is an important engineering problem too seldom recognized as such, with the result that there is and has been much wasted energy. But while it is important to know how to build roads, the great object is to so organize as to get the work done. If proper organization is provided, all the rest will be taken care of by this organization; and such an organization will include or create skilled planning, efficient direction of labor, and good finance. It is needless to condemn the ordinary township system of statute labor. It has done much good in the past under pioneer conditions, but its faults are fully apparent to those who are accustomed to good business organization. What is advocated and urged, is that a more effective system be put in its place. The abolition of statute labor is advisable only because there is a more efficient, more equitable and more business-like system available. It is useless to commute statute labor and retain fifty or 150 pathmasters to scatter the money. It is a mistake to commute or abolish statute labor, and then appoint councillors as commissioners to spend the money in such a way as to make votes instead of roads.

The best method is to follow the organization of every well-conducted business. Appoint one capable road superintendent to act as manager for the council, in supervising and carrying out works of road improvement. Centralize responsibility in one man, the council acting as a board of directors.

As previously stated, the abolition of statute labor is merely a means to an end—to make room for a better system, and every municipal councillor can render his best service by having a thorough understanding of the principles that constitute that better system. By doing away with statute labor entirely, levying a rate with ordinary taxes for road purposes, centralizing responsibility in one efficient road overseer, creating a policy of building permanent bridges and culverts, doing some permanent road work each year, and caring for all roads by the systematic use of the log drag—by such measures can a township council fully justify the abolition of statute labor.

While township councils are doing something to patch and repair roads, the most important construction is now being carried on by county councils under the Highway Improvement Act. A tree is known by its fruit; and "a corrupt tree cannot bring forth good fruit." The results under county road systems have been more or less satisfactory according to the efficiency of the organization under which they were produced. The same principles as those outlined for townships are applicable to county work; and the most important factor is the ability of the county road superintendent. There are now twenty counties of the Province building systems of roads. Returns have not been made for last year, but to the end of 1910 their expenditure has been as follows:—

Road construction and supervision	$1,790,253.91
Permanent bridges	476,765.49
Machinery, plant, etc.	145,743.32
Special grants to townships, villages and towns	112,674.84
Toll roads purchased	155,997.98
Total expenditure	$2,681,435.54

Of the foregoing total expenditure of $2,681,435.54 the Provincial contribution under the Highway Improvement Act has been one-third, or $893,811.84. Of one million dollars set aside by the Legislature in 1901 under the Highway Improvement Act there remains, after meeting payments for the work of 1910, the sum of $106,188.16; which sum will not be sufficient to meet the Provincial obligations to be incurred by work carried out during the year 1911, but as you are aware, a second million has been appropriated by the Provincial Government to continue this work.

Main Roads.—Broken stone roads of the best class have been reduced to a few well-defined types, through more than a century of experience in England, France, Germany, and on this continent. The true macadam road has a well-drained and crowned earth sub-grade, over which is spread a uniform coating of broken stone of about two and one-half inches in greatest dimension. The Telford road has a foundation of flat quarry stones, placed by hand, on edge, the angular points being chipped off by hammer and wedged into the interstices; and over all is spread a coating of fine broken stone, in thickness about one-third of the total depth of the stone surface. The earth sub-grade is flat, and larger stones are used at the centre of the road, with smaller at the sides, to give the desired camber. The roads built by Tresaguet in France were substantially the same as the Telford road, and are usually included with it. In the French type, the sub-grade was cambered, and the foundation stones of uniform depth. A distinct type of foundation is that developed in Massachusetts, in which there is a slightly V-shaped sub-grade with a filling of cobble or field stone, a method which is claimed to give, more effectively than other types, the desirable under-drainage.

*Address delivered to Ontario Good Roads Association, February 27, 1912.

Experience has shown the superiority of roads with a foundation, such as the Telford type, in reducing the cost of maintenance under heavy traffic. Settlement is more uniform, and defective drainage is less destructive. If the natural sub-soil is strongly supporting, such as a dry, well-cemented gravel, the foundation may be omitted with saving of cost. Whether the Telford or Massachusetts type of foundation be followed, the writer believes that local material suitable for either should largely govern.

County roads in Canada cannot, as a rule, follow closely English, French, German, or other standard, but must be built with a view to the particular needs of this continent, and of the locality. The need in Ontario is a long mileage, to be built as rapidly as possible, through districts where population is comparatively sparse, where there may be little or no roadmaking material, and the available expenditure necessarily restricted by these and other conditions.

European engineers would undoubtedly, if it were possible to reconstruct many of their roads, lay them with foundations, but the cost is prohibitive. No more is it practicable on this continent to build any but the most heavily-traveled roads with expensive foundations. Instead, it is necessary to depend on good drainage, carefully maintained, to keep the sub-soil dry and strong enough to sustain the road surface.

Drainage.—Bridges have to be strong enough for the maximum load, and with waterway enough for the maximum freshet. So roadbeds should have sufficient drainage for the severest test, which in northern countries is a period of thaw in the early spring, lasting usually for two or three weeks. If sub-soil drainage is sufficient for that test, no break-up of the road crust need be feared at other seasons.

Old specifications for roads built in Canada before the period of railway construction, required open drains on each side of the road, with bottom at least two feet below the crown. In many places the drain was deeper; and hills or spouty places were under-drained by trenches filled with field stone. Such roads have stood the test of time, and may be accepted as the standard of drainage required for the north; except that tile under-drains are taking the place of open ditches where they would otherwise be dangerous, unsightly, or difficult to maintain. Drains of porous farm tile keep the sub-soil at its dryest and prevent uneven settlement of the road crust into mud, which is as destructive to a road when below the surface as when on the surface. Some counties of Ontario are using tile drains the full length of all their roads. Others use them only on wet and spouty hills, on level land which is exceptionally wet and retentive, or where the open drain would otherwise have to be dangerously deep to give sufficient fall and outlet. In the last case, the tile may carry some surface drainage, receiving it in catch-basins.

Grading and Surfacing.—Closely associated with drainage is the grading of the road. Before a road is surfaced it should be brought to grades that insure permanence. Hills should be cut down, low places filled, and the earth work brought to a substantial turnpike. The road surface will need renewal, but the grade, if properly made, will outlast even the bond issue. On roads of a secondary class elaborate surveys are unnecessary. A good foreman can obtain easy-flowing gradients by grading from point-to-point, but should have an engineer's stakes and profiles in cases of extensive cuts and fills, new locations, tile drains, or doubtful surface drainage.

Roads laid on an earth foundation should be given a higher crown when newly constructed than is desirable for perfect condition. Settlement will assuredly occur, and unless the road is too high to begin with, it will become too flat. A county road as commonly built, which in two or three years has settled to the desirable camber, will give the greatest degree of durability, with least expense for maintenance. One inch to the foot from centre to gutter or edge of shoulder, for a completed, rolled road, will meet ordinary conditions. With a circular cross-section, the greatest part of the fall is on the earth shoulders.

The cost of a road, unless earth-work and drainage is of an exceptional kind, will depend on the width and depth of broken stone used. Wide, flat roads are desirable, but narrow roads with a good camber cost less to build, and much less to maintain, unless a highly organized system of maintenance is created. We have, for this class of road, found an earth grade twenty-four feet wide, shoulder to shoulder, to meet most conditions, which may be reduced to eighteen or twenty feet for least traffic. With shoulders six feet wide, the stone is commonly put on from eight to twelve feet wide. The consolidated depth of metal on county roads is based on eight inches for a moderately strong clay or loam sub-soil. This is modified according to the anticipated amount of traffic and quality of stone to resist wear; the maximum concentrated wheel loads, local tire widths, and wheel diameters, bond of road metal and consequent distributing effect of the metal crust, the supporting strength of the sub-grade and opportunity for drainage.

Bituminous binders may be justified on heavily-traveled suburban roads of this class, but present practice in Canada tends to oiling as a preservative and dust preventive, owing to the less first cost of water-bound macadam.

Binder.—The durability of a road is largely dependent on the binder and the cementing qualities of the stone dust, in producing a waterproof surface—if tar or other bituminous binder is not used. We are strongly in favor of the use of stone screenings as opposed to sand, and have very rarely found gravel or sand sufficiently clean, coarse, and sharp to satisfactorily take the place of screenings as a binder. Wherever practicable, stone screenings are to be recommended, particularly the screenings of certain classes of limestone; the superior cementing qualities of which make it better road metal than its degree of toughness would justify. Limestone screenings are exceedingly useful with water-washed gravel, or with broken granite or trap.

Coursing Stone.—A uniform grade of stone, rather fine, is desirable in finishing the surface, and is necessary where a very hard stone such as trap is employed, but this may be sought at considerably increased cost, and is not always necessary to suitable results. It adds to the cost of a road to spread the stone in several layers. Municipalities using portable crushers will find a rotary screen with two sizes of mesh very satisfactory. This will produce (1) "tailings," or the stone too large to pass through the screen; (2) the middle course, a uniform grade to form the main body of the road, and (3) "screenings" to bond and finish the surface. The tailings should be spread in the bottom of the road, and covered to the required depth with the uniform grade; and this, after rolling, may be lightly coated with screenings and rolled. If a very tough stone, such as trap, the screenings may be such as will pass a one-inch mesh, or a one and one-half inch mesh if limestone, and the uniform grade of stone may be two-inch for trap, and three-inch for limestone, with the screenings removed. Crushing and handling are cheapened by this system, and, for water-bound roads, a smooth surface results.

Local Material.—Trap or other tough rock brought from a distance by rail in preference to the use of soft local material, may be justifiable for surfacing heavily-traveled main roads; but it is a safe rule, if applied with discretion, that local material, if it exists, should be used. Much will depend on the teaming required but for moderate wagon hauls up to two miles, on highways of the second and third classes, the writer has commonly found gravel roads being built for

$100 per mile for each foot in width of metal. If local broken stone is used, the cost is, all things equal, about doubled, or $200 to $300 per foot, and if imported by rail, about $300 to $400 per foot. Taking, then, a road not requiring much grading, and with eight feet of metal and eight inches in consolidated depth, the cost might be stated, for cheap construction, at $800 or $1,000 a mile for a gravel road; $1,600 to $2,400 a mile for a road built of local crushed stone, and $2,400 to $3,200 per mile if the stone is brought in by rail. These prices are for the cheapest class of road that can be built, and the main roads of the province should have a much heavier type of construction.

Gravel Roads.—Gravel in general is inferior to broken stone as a road material, but if of a reasonable quality, is suitable for roads of the third-class—township roads—and for many market roads of the second class, but unless of exceptional quality is deficient for heavy traffic. The rounded pebbles do not take the mechanical clasp that pertains to fragments of broken stone, while the sand which it usually contains is not equal to stone screenings as a binder. It may contain lime or iron, improving its bonding qualities, but as a rule it is not waterproof, and ruts readily in wet weather, especially if it contains sand, clay, or loam in excess.

The best quality of gravel is of varying sized grain up to two inches in greatest dimension, with only sufficient fine material to fill the voids between pebbles. It should be clean and made up largely of a uniform grade of pebbles—qualities rarely found in natural pit gravel. Gravel pits containing a mass of large stones and boulders should be treated as rock, and put through a crusher. Gravel which is not coarse, but which is "dirty," should be screened to remove the excess of sand or clay. A rotary screen may be used, operated by steam power. The gravel can be drawn in wagons to an elevated platform, dumped into a hopper from which it passes through the rotary screen, and from the screen to an elevated bin, from which the screened gravel is again loaded into wagons to be taken to the road. By means of the elevated bins the expense of shoveling into wagons is saved, the time of teams and teamsters is saved, and a well arranged plant will, under favorable circumstances, pay for crushing and screening. This is particularly the case if a pit near the work can be used rather than to team better material a long distance.

Methods.—The methods of construction will largely determine the cost. Machine work is cheaper than manual labor. The cross-section adopted should, therefore, permit the maximum amount of machine construction. Particularly for the cheaper class of roads, the grading machine, in treating with old locations, should do most of the earth work, supplemented with wheeled and drag scrapers. The cheapest and best plan, in our experience, has been to make the earth sub-grade, shoulder to shoulder between ditches, almost flat, or with a central rise of about three inches for a twenty-four foot grade. When this is rolled the stone is spread to the desired width in the centre, then with the grading machine, earth is drawn from the shoulders to support the stone, thus completing the camber. The stone is rolled dry to level the surface, the screenings are spread, sprinkled, and rolled till consolidated. To grade the road and then excavate a central channel to receive the metal is a more expensive method, and is apt, for roads without a foundation, to place the stone too low for good drainage, producing what may be termed a "water-logged" road. Instead of the camber and turnpike being high enough to allow for settlement, it is apt to be made too low and flat.

Rolling.—As distinguished from earlier road making, modern construction has been largely influenced by machinery, especially grading machines, rock crushers, and road rollers. The smaller municipalities of Canada commonly use graders and crushers, but the purchase of a steam roller is too often delayed. It is to be pointed out that the cost of a roller is by no means an additional expense, since rolling effects economy in several ways. Coarser stone can be used in a road that is rolled, so that the cost of crushing is reduced. With coarser stone, the road is stronger to resist wear, and is more securely bonded than if first rutted and mixed with mud. Less stone is required in a rolled road, as loose stone is largely forced down into the mud before the surface becomes waterproof, or is knocked to the ditches by traffic. Without rolling, roads demand attention for one or two years, to rake the stone to place from time to time; the earth shoulders have to be restored and leveled where cut up and destroyed by traffic, new material has to be added to fill hollows and ruts. By rolling the sub-grade, the wet or weak spots are developed, which can be drained or filled with earth and again rolled to produce a uniform foundation; thereby reducing the stone which the road would otherwise absorb. Long lines of loose stone left for traffic to consolidate are a most objectionable obstruction to travel, and bring road building into disrepute. On the other hand, a road built with a heavy roller is a complete work, in perfect condition when finished. Rolled roads are a revelation to those who have been accustomed to and who expect only old-time methods and results. For economy, service, and to popularize the work, rolling should be regarded as essential for every class of gravel and stone roads.

BUILDING FIGURES.

The past year was another one of active building operations and the fact that this condition was general is additional proof of national rather than sectional progress during 1911. The building of warehouses, factories, office blocks was a marked feature, while there was no slackening in the demand for residences. The current year will probably witness the construction of a considerable number of workmen's cottages in all parts of the country.

The following statistics show the value of building operations during the past two years, in 20 selected cities and towns:—

City or town.	1910.	1911.
Brandon	$1,224,385	$1,142,939
Calgary	5,589,594	12,907,638
Edmonton	2,161,356	4,328,960
Fort William	2,381,125	3,078,010
Halifax	471,140	548,734
Hamilton	2,604,605	4,255,730
Lethbridge	1,210,810	1,033,380
London	805,074	1,036,880
Montreal	15,815,859	14,657,210
Ottawa	3,040,350	2,997,610
Peterborough	517,958	345,372
Port Arthur	1,062,616	597,705
Regina	2,351,288	5,089,340
St. Thomas	286,650	285,515
Sydney	347,554	495,642
Toronto	21,127,783	24,250,000
Vancouver	13,150,365	17,652,642
Victoria	2,271,095	4,026,315
Windsor	392,040	739,515
Winnipeg	15,106,450	17,600,000

The value of the building permits issued last year as a rule exceeded the value of the previous year. The most remarkable increases were at Calgary and Regina, which more than doubled their figures. Large gains were also made at Hamilton, Toronto, Vancouver, Windsor, and Winnipeg.

PERMANENT STRUCTURES.*

By James S. Bell, C.E.

Permanent structures as applied to municipal public works are those structures which, when properly built, will remain and fulfil the requirements for which they were intended for the longest possible period. It is not possible to build structures that will stand forever. They are all subject to wear and decay. The whole object is to get a material at reasonable cost, that will, when placed in position, stand the ordinary wear and tear of vehicular or other traffic, and the action of the elements as long as possible without excessive repairs.

The rapid increase in the manufacture of Portland cement and reduction in cost, has made the use of concrete available for a multitude of purposes, and to no use is it more applicable than in building such structures as bridges, abutments, culverts, retaining walls, etc. Taken in combination with steel—the steel being properly imbedded in the concrete—the two materials combine and assist each other in resisting the stresses brought upon them, each material serving the purpose for which it is best adapted.

Brick and stone were formerly used for building abutments, and in some cases, arch bridges and culverts, but only to a limited extent, on account of the difficulty of procuring the material and the cost of placing it at the site of the proposed work. On the other hand, most of the ingredients entering into the composition of reinforced concrete are to be found in every township, and in many districts, in every concession. The cement and steel have only to be hauled from the nearest railway station; and as these ingredients in the mixture are by far the least portion, it is not expensive to haul them comparatively long distances.

Plain Concrete: Plain concrete is admirably adapted to the construction of works where it is only used in compression, such as abutments for bridges. Even for that purpose the use of a comparatively small amount of steel properly imbedded in the concrete will permit of a considerable reduction in the quantity of material used, and in most cases will also show a saving in cost. At the same time it will add materially to the strength and stability of the abutment, by uniting it more firmly together and making it less susceptible to cracks from expansion and contraction.

Concrete Pipe Culverts: Small culverts up to three or four feet in diameter can economically be built with concrete pipe—preferably reinforced—but these should always be protected at the ends with concrete abutments and wing walls, to prevent the water washing out the earth under them, and permit the free entrance and exit of the water.

The pipe should be made with hub and spigot ends, and be placed close together and cemented, so that there will be no chance of water leaking through the joints and making its way under the pipe. Should this occur, there is danger of the earth being washed out below and thus cause a failure of the culvert.

Short Spans: Culverts from four feet to eighteen feet can be more economically built with flat tops, when properly reinforced, than by arch construction. The side walls should be made about one foot in thickness up to sixteen feet in height, and the footings wide enough to suit the density of the ground on which they stand.

The wing walls should have a base of at least one-third the height and be supported by either counterforts or buttresses.

Beam Bridges: For spans over eighteen feet and up to forty feet beam bridges are the cheapest and give greater water-way than arch construction.

The side walls should be made heavier than for flat top culverts in order to safely carry the increased load and beams. Wing walls should be built the same as for flat top structures.

There are cases where beam construction has been used up to seventy-five feet, but generally they are not economical for a span over forty feet.

Arch Bridges: Concrete arch bridges will compare favorably in cost with steel construction in spans of forty feet to one hundred feet, and in cases where the material for concrete is easily obtainable, this length may be considerably increased. In the construction of arch bridges a perfect foundation is absolutely essential.

In flat top and beam bridges there is no longitudinal thrust. The whole weight of the structure and load is a downward pressure. But in arch construction there is an outward thrust pressure that has to be met with an increased weight of concrete supported by a perfect foundation. Should the foundations of an arch bridge give way, the result would likely be the destruction of the bridge. In the case of a flat top or beam bridge, the settlement of a foundation might not seriously affect the structure; although in every case it is advisable to secure a perfect foundation for any kind of a structure.

Steel Superstructures: For bridges over one hundred feet span it is generally considered more economical to build them of steel on concrete foundations, and in every case they should be made strong enough to support a solid floor. It is quite true that the life time of a steel bridge is not as great as that of concrete, but with proper care and attention, keeping the steel well painted, a bridge of this type should be safe for at least fifty years.

It is said that there is a cast iron bridge in France on the Seine River that was built in 1801 and is still in use.

Kind of Bridges to Build: The question of determining the kind of structure best suited to any particular crossing of a stream, can only be made after a careful examination of the site and its surroundings. No two sites are alike, and therefore a study of local conditions and requirements is necessary in every case before a recommendation can be made as to the best and most economical structure to build.

Great care should be taken to have the foundation built so that in future years there will be no danger of undermining by the scouring action of the water.

Size of Openings: Determining the length and height of openings is also an important matter. Freshets will undoubtedly be greater in future as the country becomes better drained. Ample room should, therefore, be provided for the water, for if confined in too narrow a space, scouring of the bed of the stream is sure to occur and consequently injury to the structure.

Design of Structure: In designing a structure, the first consideration should be the public safety. It is far better to provide in excess of the requirements than to have the structure too weak. Then loss of life would probably be the result Cheapness in construction should never be considered as against the security of the traveling public.

It is an undoubted fact that a large number of the steel and iron bridges that have been erected throughout the province are now inadequate for present traffic conditions. This is not all due to imperfect design or construction. Traffic conditions twenty years ago were quite different to what they are to-day. At that time the heaviest load to provide for would probably be a threshing engine or a drove of cattle. Now the law provides that bridges shall be safe for the

* Paper read at Ontario Good Roads Association meeting, Toronto, Tuesday, February 27th, 1912.

passage of a traction engine not exceeding in weight eight tons, and where roads are now being systematically improved, it is necessary that they be sufficiently strong to carry a fifteen ton steam roller in addition to the live load provided.

Bridge Floors: Very few of the bridges that have been erected with wooden floors are strong enough to carry a floor of concrete. In some pin connected bridges where the top chord and batter posts are strong enough, the other members can be strengthened sufficiently for this purpose, but in most cases it means the rebuilding of the superstructure.

All bridges where possible should be constructed with solid floors. Vehicular traffic on wooden floors causes a greater strain and vibration to the bridge than the same loads on a solid floor. This is caused by the irregularities of the plank when worn, and projecting knots. On a solid floor the surface is much smoother, and in consequence of it being a large slab, the stresses are distributed over a larger area.

Traction Engines: The cutting action of the lugs of traction engines is very destructive to wooden floors, particularly when they are soaked with water; and although the "Act" provides for planking to be laid under the drive wheels of the engine, this is rarely complied with.

Plans and Specifications: All plans and specifications of steel bridges should be submitted to and approved by a competent tribunal before erection. This is more necessary in the case of steel bridges than of concrete. If a reinforced concrete bridge, after the forms are removed, shows no defects, then after thirty days it is reasonable to suppose that it will stand the ordinary travel, and as its strength increases rapidly, there is little to fear for its safety. But in a steel bridge the reverse is the case. It is strongest the day it is completed, and from that day it decreases in strength.

The Legislature last session passed an Act providing that the specifications of all County Bridges should be submitted to the Provincial Engineer of Highways for approval before being built. As the majority of the bridges in the province—and in many cases those most traveled upon—are under control of the minor municipalities, this Act should apply to all bridges.

Inspection of Steel Bridges: Rigid inspection of steel bridges after erection, by a competent person, should be compulsory. The design and specifications of a bridge may be all that is desired, but if the erection is defectve, then the whole intention of the design is a failure. This inspection should be made immediately after erection and before any painting is done. All rivets, particularly those in tension members, should be carefully examined and each one tested with a light hammer to see if they are loose or do not fill the holes properly. All loose or imperfect rivets should be cut out and properly replaced.

The Provincial Engineer of Highways in his last report, has an amended specification for steel highway bridges, which if lived up to, will ensure the completion of better bridges in future. Proper inspection after erection is the only way to guarantee that those specifications are effective.

Inspection of Concrete: For concrete structures it is very important and necessary that a competent inspector should have charge of the work. He should be able to thoroughly understand the plans and specifications prepared for the work, and also have a knowledge of the different ingredients that make up the concrete, how to mix and place them in position. He should also know how the forms for holding the concrete should be made and placed, and see that they are strong enough to resist the pressure of the wet concrete. Good results can only be obtained by a thorough knowledge of materials and how to prepare and place them in position.

Painting: Keeping steel bridges well painted is a matter that should not be forgotten. Unpainted or imperfectly painted bridges deteriorate very rapidly in strength, and although a fair margin of safety is provided in the design, a failure to properly protect the steel will soon reduce the strength of the bridge to a point where it will be unsafe.

UTILIZATION OF WASTE STEAM AT THE MILWAUKEE REFUSE INCINERATOR.

At the November meeting of the Milwaukee Section of the American nstitute of Electrical Engineers, held in cooperation with the Engineers Society of Milwaukee, Mr. J. A. Neseroff, city engineer of Milwaukee, presented a paper on "The Utilization of Waste Steam at the Refuse Incinerator and the Electrification of Two River Flushing Stations."

The City of Milwaukee now operates a refuse incinerator in which all classes of refuse are burned in special furnaces under special boilers. At the present time the steam is blown off except a very small portion used to run the plant. Tests made showed that the steam available varied widely, depending on the grades of refuse, being lowest when green garbage was fed to the furnaces. Further tests showed that by adding a very small amount of coke dust to the charges of green garbage, enough steam could be raised to produce 600 kw. at all times, although at some times nearly three times this amount would be available.

Since it is undesirable to make a large investment in machinery at this time, it has been decided to install one 600 kw. steam turbine and proper auxiliary apparatus in a new engine house adjoining the incinerator. The nature of the steam supply and the absence of spare units made it inadvisable to utilize this power supply for service requiring great reliability, and street lighting would not be economical by reason of the absence of any day load. The city, however, now operates by steam two pumping plants taking water from the lake and forcing it through tunnels into the rivers running through the city, for the purpose of flushing them to carry off sewage. One plant is only two years old, with a capacity of about 200 horse-power, while the other is 24 years old, with a capacity of about 250 horse-power. Both run practically continuously, but a few hours shut-down would not be disasatrous. This load therefore seems ideal as an outlet for the power available at the refuse incinerator.

The plans contemplate 6,600-volt three-phase underground transmission to induction motors in the two pumping stations, about two miles in each case, and the removal of the present steam engines. The motors will be geared to the present shafts.

Figures were given of the cost of operation of the present steam pumping stations and it was shown that by an investment estimated at $80,000, a saving of approximately $28,000 a year could be made. This did not make any allowance for interest or depreciation on the new investment, nor did it include any value for the steam that will be used. As the steam is now a waste property of the city it is merely a matter of bookkeeping whether the economy is shown in the pumping plant by using waste steam, or whether the steam is charged against the pumping stations, and the economy shown in the operation of the incinerator.

The discussion which followed the reading of the paper was general, and involved criticisms of the present operation of the steam plants and suggestions that other more profitable markets be selected for the use of waste steam, but no practical suggestions were made that appeared better than the plan already adopted.

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BOOK REVIEWS.

Geodetic Surveying. By Edward L. Ingram. Published by The McGraw Hill Book Co., New York. Cloth; 289 pages, including index; size 6½ x 9¼ inches; 92 figures; 10 tables; price $3.00.

The author of this treatise is Professor of Railroad Engineering and Geodesy at the University of Pennsylvaia, and the full title of the volume is Geodetic Surveying and the adjustment of Observations (Method of Lease Squares). Up to the appearance of this treatise there has been a lack of a satisfactory text from which to teach civil engineering students the fundamental principles of geodetic surveying and the adjustment of observation. It was with the intention of filling this need that the volume was compiled. In order to make the book complete for the practising civil engineer a large amount of other matter has been included. A large number of illustrative examples are given and are worked out in detail, so that every process may be fully understood.

Strength of Materials. By James E. Boyd, M.S. Published by The McGraw Hill Book Co., New York. Cloth; size 6½ x 9¼ inches; 295 pages, including index; 200 figures and 15 tables; price $2.50.

Many treatises have been published recently on the subject of "Strength of Materials," and some of these have been very good. This new volume is a valuable addition to the subject and is intended to give the student a grasp of the physical and mathematical ideas underlying the mechanics of materials, together with enough of experimental facts and simple applications to sustain his interest, fix his theory, and prepare him for the technical subjects as given in works on machine design, reinforced concrete, or stresses in structures. It is assumed that the reader has completed the integral calculus, and has taken a course in the theoretical mechanics, which includes statics and the moment of inertia of plain areas. The book is a well-balanced, logical exposition of the subject, and will be found a valuable text for the student of the strength of materials.

The Law Relating to Engineering. By L. W. J. Costello. Published by the Society of Engineers and the Junior Institution of Engineers, London. Cloth; size 6 x 8¾ inches; 170 pages; including index; price $1.60.

This book is a course of six lectures delivered at Caxton Hall, Westminster, in 1910 and 1911, before the Society of Engineers and the Junior Institution of Engineers, by the author. There is also an introduction by Lord Justice Fletcher Moulton, past president of the Junior Institution of Engineers. The lectures comprise a judicious selection of the decided cases in law bearing on the matters with which the engineering profession have to deal, the cases being arranged in such manner that those that relate to each point come together. The perusal of them will benefit the most experienced, and will give invaluable training to the beginner. While the cases all came up in the English courts, still they are of great interest to the Canadian engineering profession.

Efficiency. By Harrington Emerson. Third edition, revised and enlarged. Published by The Engineering Magazine, New York. Cloth; size 5¼ x 7½ inches; 254 pages; price $2.00.

This volume forms one of the Works Management Library published by this company, and the full title is "Efficiency as a Basis for Operation and Wages." The rapid expansion of interest not only in the pursuit of efficiency, but in Mr. Emerson's interpretation of it as applied to industrial affairs, exhausted the first two editions in a very short time. In this third edition the author has made a thorough revision of his text, elucidating points upon which experience has shown added emphasis must be laid, adding sections to cover the development of thought and practice since the first draft was written and establishing points of connection between this volume and the following one on the twelve principles of Efficiency. The principal changes will be found in chapters 4, 5, 6 and 7.

The Twelve Principles of Efficiency. By Harrington Emerson. Published by The Engineering Magazine, New York. Size 5¼ x 7½ inches; 423 pages; price $2.00.

This is the latest work by Mr. Emerson and follows the volume entitled "Efficiency as a Basis for Operation and Wages," a review of the revised edition of which will be found in this issue of The Canadian Engineer. In this latest volume Mr. Emerson reduces the elements of efficiency to definite and clearly defined principles. These principles are so universal that they may be used to test the efficiency of an existing organization, or they may be made to serve as guides in directing the conduct of further enterprises. The method of treatment is simple and logical. An introductory chapter lays down the premise that the prime institutions for the attainment of efficiency are not men, materials, money, machines, methods, but theories of organization and principles, and that inefficiency prevails because the type of organization in general use does not lend itself to the application of efficiency principles. The second chapter discusses the type of organization under which efficiency principles can be successfully applied. The twelve following chapters take up each one a single principle: 1, Ideals; 2, Common-Sense and Judgment; 3, Competent Counsel; 4, Discipline; 5, The Fair Deal; 6, Reliable, Immediate and Accurate Records. 7, Planning and Despatching; 8, Standards and Schedules; 9, Standardized Conditions; 10, Standardized Operations; 11, Written Standard-Practice Instructions; 12, Efficiency Reward. The two concluding chapters show how the principles are applied as a means of diagnosis of industrial conditions and correction of existing inefficiencies.

Engineering as a Vocation. By Ernest McCullough, C.E., M. Am. Soc., C.E., etc. Published by David Williams Company, New York, N.Y. Cloth; 5¾ x 8 inches; 201 pages; 4 illustrations; 6 tables; price $1.00.

The book takes up first the definition of the word engineer and what is meant by engineering. Then is discussed the work and the education of the engineer, one chapter containing a full list of studies pursued at schools of civil, mechanical, electrical and mining engineering. The statement is made that the modern engineer should have a college education or its equivalent, the author mentioning that the

equivalent is very hard to obtain. To show what the self-tutored man is apt to encounter and to help him accomplish his purpose he gives a list of books to study, with the price of each book. Directions for home study are also given, the author being a man who is ready to admit that many first-class engineers never saw the inside of a technical School. There is a long chapter entitled "Does it Pay to Study Engineering?" which the reader cannot help but feel is largely autobiographical. An appendix containing reprints of editorials from prominent engineering papers is somewhat pessimistic in tone; more so than anything the author seemed to dare write. Contractors should be interested in this book, the author believing an engineering education the best, if contractors care for a college training. He refers to contracting as "migratory manufacturing" and calls attention to the great changes in methods since engineers entered the field. The author has a pleasing style, the pages being enlivened occasionally by quiet humor. The book will be useful to young engineers in setting before them the reasons for non-success and showing them how to advance. It will be interesting, because reminiscent, to older engineers, and if required to be read by every high school student and freshman in college will undoubtedly prevent many fine young fellows from making a mistake in selecting a vocation for which they may be totally unfit.

Tests on Reinforced Concrete Columns. By Morten Owen Withey. Has just been issued as Bulletin No. 466 of the University of Wisconsin. This bulletin is 116 pages in length; size 6 x 9; and records the tests on columns of the series of 1910. These tests were made in the laboratory for testing materials of the University of Wisconsin, and are a continuation of a branch of the work reported in Bulletin No. 300. The purpose of these experiments was to make a further study of the strength and elastic properties of columns reinforced with spirals and longitudinal rods. Copies of Bulletin No. 466 may be obtained by addressing the librarian of the University of Wisconsin.

Pipes and Tubes. By P. R. Björling. Published by Whittaker & Company, London. Size 5¼ x 7 inches; 244 pages, including index; price $1.00.

This little volume which forms one of the series of Whittaker's library of Arts, Sciences and Industries, deals with the construction and joining of pipes and tubes, together with many rules, formulae and tables. The chapters on Construction and Laying of Pipes are exceedingly good, and while they represent English practice, will be very useful to any engineer interested in this subject.

Mining Without Timber. By Robt. Bruce Brinsmade, B.S.E.M. Published by McGraw Hill Book Co., New York., 239 West 39th Street, New York, 1911. Size 6½ x 9½ inches; 309 pages, including index; 146 figures; price $3.00 net.

This book has been written to supplement many other valuable treatises on such work, such as Mayer's Mining Methods in Europe, Storm's Timbering in Mining, and those books also dealing with the financial side of mining, which include Ingall's Economics of Mining, Hoover's Principles of Mining, and Finlay's Cost of Mining. The mining industry is becoming alarmed as to its future supply of the big timber of which it has hitherto been such a prodigal consumer on account of the rapid depletion of the forests of America by fires and the axe in recent years.

The use of steel and masonry for the support of mine shafts and tunnels, the author states, has long been practised in Europe because most mines there are considered to be investments rather than temporary speculations; this system has been thoroughly covered by other writers, and has not been touched on in this treatise. The book deals with the various systems of excavation with such additional matter regarding exploring, blasting, explosives and the control of ground as is necessary for the elucidation of the main theme.

This book should be well received by both coal miner and metal miner, for they will find a great deal of interest in it.

Street Lighting. By J. M. Bryant and H. G. Hake, has just been issued as Bulletin No. 51 of the Engineering Experiment Station of the University of Illinois.

Efficient and economical street lighting is a subject on which little information of a definite and tangible character has been published. Bulletin No. 51 is designed to supply such information concerning electric street lighting. The subject has been treated in a simple, direct manner, and while of especial interest and value to the technically trained illuminating engineer, will appeal particularly to city councils and central station managers.

The general theory and construction of electric lamps, both incandescent and arc, are discussed, together with the standard systems of electric distribution for lighting, and accepted methods for the measurement and study of illumination, with and without shades and reflectors.

These principles are then applied to the study of street illumination, curves and calculations being given to show the candle-power distribution for the various lamps used, equipped with their proper glassware and reflectors, and others to show the illumination along the street for representative installations and conditions. Based upon these results, a discussion is given of the proper lighting of business streets, cross streets, boulevards, residence streets and outlying districts. The subject of economy for the several systems and lamps is thoroughly discussed—the initial cost, upkeep, interest and depreciation of various lamps and equipment are considered in tables and curves showing their relative economy at standard costs of power. Attention is given also to the economical selection of different lamps for certain classes of illumination.

Copies of Bulletin No. 51 may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

An Investigation of the Strength of Rolled Zinc. By Herbert F. Moore, has just been issued as Bulletin No. 52 of the Engineering Experiment Station of the University of Illinois.

For many years engineers have been studying the strength of iron and steel, and though much remains to be learned about these, the commonest of metals, yet we have sufficient knowledge of their strength and stiffness to enable them to be used safely and economically. Very little attention has been given to the study of the strength of zinc, though that metal has had a wide use on account of its rust-resisting and electric properties. Zinc has, in fact, rarely been used in places where heavy loads were liable to be imposed. Recently, it was proposed to use loops of sheet zinc to suspend electric cables, and it became important to determine the strength of zinc so that such hangers could be designed to carry heavy cables with safety. The Engineering Experiment Station of the University of Illinois, at the suggestion of an Illinois zinc works, undertook the investigation of the strength of zinc, and the results of the investigation have just been published in this bulletin. The tests performed showed that thin sheet zinc is about one-third as strong as soft steel plate of the same thickness, and that a punch or shear which would punch or shear steel plate one-tenth of an inch thick would punch or shear zinc plate about one-quarter of an inch thick. Zinc plate was found to break under pull with much less stretching than steel, but a cylinder of zinc could be flattened out without cracking.

Copies of Bulletin No. 52 may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Retaining Walls for Earth. By Malverd A. Howe, C.E., Professor of Civil Engineering, Rose Polytechnic Institute. Published by John Wiley & Sons, New York. Canadian agents, Renouf & Co., Montreal. Fifth edition, revised and enlarged; size 5x7½ inches; 181 pages; price $1.25.

This little volume, now in its fifth edition, treats of the design of retaining walls for earth, including the theory of earth-pressure as developed from the ellipse of stress. It contains also a short treatise on foundations, illustrated with many examples from practice. The captions for the different parts of the book are: Theory of Earth Pressure; Formulas for Earth Pressure; Stability of Trapezoidal Walls; Formulas for Trapezoidal and Triangular Walls; Foundations for Walls Retaining Earth; Examples; Foundations; Foundations Under Water and Deep Foundations; Tables; Appendices. Not the least valuable part of the volume are the appendices, which are devoted to the analysis and design of reinforced concrete retaining walls, and the profiles of gravity walls retaining earth. This little volume should be in the library of every engineer engaged in the design of walls or foundations, for the theory and practice is closely and concisely presented.

Concrete in Cold Weather is the title of a new booklet published by the Universal Portland Cement Co., of Chicago and Pittsburg. The subject matter of this very seasonable book is the mixing, handling and depositing of concrete in freezing weather. The booklet is particularly valuable at this time by reason of the increased use of cement during the winter months and on account of the demand for rapid building construction.

The necessity of a work of this character has long been felt by architects and cement users generally. This is perhaps the first time that any thorough study of the subject has been published in pamphlet form. The booklet contains much matter of great practical value to persons interested in doing concrete work properly in the winter months. The booklet may be had, free of charge, upon request to either the Chicago, Pittsburg or Minneapolis office of the Universal Portland Cement Co.

Economies of Contracting. By Daniel J. Hauer. Published by E. H. Baumgartner, Chicago. Cloth; 269 pages; size 5½ x 8½ inches; illustrated; price $2.50.

The author of this book is the eastern editor of The Contractor. Mr. Hauer has had an engineering training as well as practical experience as a contractor. Therefore his ideas will be calculated to command respect. He holds that contracting is a profession, and as such, may be studied as any of the other professions are. The volume is addressed to students of the subject as well as to the older men, who may feel that some advance in efficiency may be made in this work. The book contains ten chapters. The first deals with contracting as a profession, stating the way in which one may go into the business: first preliminary study, then by joining a partnership or corporation or acting as a subcontractor. General legal considerations regarding contracts are stated, such as matters of payment, breach of contract and ownership of materials of construction. The second chapter states the various forms of contracts, unit price, lump sum, percentage, cost plus a fixed sum, etc. Considerations regarding proposals, bonds, arbitration and other features, are discussed in the third chapter. The formal proceedings which a contractor must go through from the making out of his bid to the receipt of his final payment make up the subject matter. The chapter on the business end of contracting endeavors to outline in a general way the methods by which contracts may be obtained. The reputation of the contractor, his financial standing, as prerequisites to the obtaining of work, are emphasized. The relations of the engineer and contractor are also discussed. The fifth chapter deals with the clerical end of contracting. Herein are matters that should interest the older contractor. The office work, organization, execution and financial department are discussed. The subject of daily and other reports of progress and cost keeping and cost data are gone into. Chapter six deals with the labor question, obtaining workmen, transporting men, the welfare of laborers, wages and efficiency. The seventh is an interesting chapter on construction camps, covering the subject from the selection of a site to the supply of drinking water and lights. Under the caption "Management of Men" are laid down certain rules of management, which, however, will still require the intangible elements of leadership. The ninth chapter, on contractors' outfit and plant, is a long one, and outlines the chief classes of items in a contractor's equipment. The tenth chapter is entitled a personal chapter for the contractor dealing with the prevention of accidents, etc. An addenda gives a talk on specifications, and useful books for the contractor. Altogether this is a most valuable book for the contractor and engineer.

Highway Engineering. By Arthur H. Blanchard, C.E., and Henry B. Drowne, C.E. Published by J. Wiley & Sons. Renouf & Company, Montreal, Canadian Agents. Pages 299; price $2.

The object of the authors in writing this book appears to be to render available to those interested in the progress of highway engineering the large mass of information relative to the construction and maintenance of roads and pavements which was presented by the various reporters and contributors at Brussels in 1910.

The authors, appreciating the valuable knowledge which may be acquired by a close observance of the practice of highway engineering in the various countries of the world and believing that it is possible in many cases to profit by the successes and failures of others who have worked in similar fields and thus avoid costly duplication of experimental work and the waste of public and private funds through the adoption of methods which have resulted in unsaisfactory roads and pavements, wish to emphasize the fact that the subject of foreign practice has not received the attention it deserves by American engineers.

The main part of the book is devoted to the presentation of the fundamental facts and salient opinions submitted to the Congress and the discussions at many sessions of the Congress which occupied over two hundred pages of the "Report of the Proceedings of the Congress," recently published by the Association. It should be borne in mind that the reporters selected by the Executive Committee were instructed to cover in their reports the progress in the particular field assigned relative to the practice of the countries which they represented. The conclusions which were finally adopted by the Congress were the outcome of thorough consideration and ofttimes strenuous debates by highway engineering experts from all parts of the world. It is self-evident that through the medium of an International Road Congress a very comprehensive review of foreign practice is presented.

The plan adopted in the compilation of the book has been to collate the material under headings familiar to American engineers. Discussions in every case follow the reporter's name, hence quotation marks were not used although in some cases the words of the reporters were employed, but generally the object of the authors was attained by presenting the important ideas of the reporters in

abstract. The discussions on a given topic relative to the practice in a given country have been congregated while the groups thus formed have been arranged in alphabetical order in each chapter.

Modern methods of road building are improving so quickly that a discussion such as took place at this congress must be of exceptional value to road builders and this volume is an added advantage, in that the material has been selected and arranged by a prominent highway engineer, a man who has a clear appreciation of all that is required.

Steam Power Plants. By Henry C. Meyer, jr., M.E.; third edition, revised and enlarged. Published by McGraw-Hill Book Company, New York; 6 x 9¼ in.; 219 pages, including index; 67 illustrations. Cloth; price $2.

The first edition of the book appeared in 1902, and shortly after the author began to practise as a consulting engineer for power-plant design. This revision therefore entails many changes and additions, including the experience gained in actual work. The chapter on turbines is new, and a great deal of new matter is added on the subject of steam piping, condensers and chimneys. A good deal of space is devoted to the structural parts of installations, such as foundation design of chimneys, design of boilers, etc.; and here it is noticed that the author quotes empirical rules and formulae without going into the mathematical derivations. When an engineer uses a formula he desires to know on what basis it is founded. However, by doing this the author has brought the book to a reasonable size, while at the same time covering the subject well. The book is closely written and will be found very valuable to the mechanical engineer interested in the design of steam power plants.

Roofs and Bridges, Part III, Bridge Design. Fifth edition. By Mansfield Merriman and Henry S. Jacoby. Published by John Wiley & Sons, New York. Renouf & Co., Montreal, Canadian Agents. 6 in. x 9 in.; 414 pages; 185 illustrations; cloth. Price $2.50.

The first edition of Merriman and Jacoby's text book on Roofs and Bridges was published in 1894, and the fact that it has been standard in many institutions during the intervening years is evidence of its value. It has been revised four times—in 1896, in 1898, in 1902, and in 1912. The changes in bridge design and construction during the past ten years have been very important and the present revision was made necessary in order to include practices which have become standard. The principal change in the new edition is the complete rewriting of the chapters on Fabrication and Erection, Highway Bridges, Railroad Riveted Bridges, and several other articles. The subject of erection is added in the first chapter mentioned, the matter being well covered by Warren B. Keim, assistant engineer of the Pennsylvania Steel Company. The chapter on highway bridges is entirely new, being written by F. O. Dufour, assistant professor of structural engineering, University of Illinois. While the new volume gives latest details of bridge practice, the matter is presented especially for students and young engineers, the experience of the authors qualifying them well for presenting the subject to this class of readers.

PUBLICATIONS RECEIVED.

Annual Report of the Smithsonian Institution, 1910. Showing the operations, expenditures and conditions of the Institution for the year ending June 30th, 1910.

Report on the Geology and Mineral Resources of the Chibougamau Region, Quebec. A report by the Chibougamau Mining Commission, composed of Mr. E. R. Faribault, Mr. J. C. Gwillim, Mr. Alfred E. Barlow, for the Department of Colonization, Mines and Fisheries, Mines Branch, of the Province of Quebec.

Annual Report of the Department of Railways and Canals of the Dominion of Canada, for the year ending March 31st, 1911.

Steamboat Inspection Report. Supplement to the 44th annual report of the Department of Marine and Fisheries for the year 1911.

The Road Material Resources of Minnesota. By George W. Cooley, Bulletin No. 40, of the Office of Public Roads, United States Department of Agriculture.

Report of the Director of the Office of Public Roads for 1911. By Logan Waller Page, Director, United States Department of Agriculture.

Wood Distillation, 1910. Bulletin No. 7, Forest Products, Department of Commerce and Labor, Bureau of the Census, United States.

The Annual Report of Water and Lighting Department, City of Harrisburg, Pa., for the year 1911, being the 24th annual report of the Board of Commissions.

Reports of the Harbor Commissioners for Montreal, Quebec, etc. Supplement to the 44th Annual Report of the Department of Marine and Fisheries for the calendar year ending 31st of December, 1910.

Report of the Board of Governors of the University of Toronto, for the year ending 30th of June, 1911.

Railway Statistics of the Dominion of Canada for the year ending June 30th, 1911, compiled by A. W. Campbell, Deputy Minister of the Department of Railways and Canals.

New Hampshire Highways. Bulletin No. 42, Office of Public Roads, United States Department of Agriculture. A report of an inspection of Highways in the State of New Hampshire, August, 1911, by Charles H. Holt, superintendent of construction.

Technological Papers of the Bureau of Standards, United States. No. 5, the effect of high pressure of steam on the pressing strength of Portland cement mortar and concrete, issued by the Department of Commerce and Labor, United States.

Proceedings of the Fourth Annual Convention of the Indiana Sanitary and Water Supply Association, held at Indianapolis, February 9-10, 1911.

Directory of Portland Cement Manufacturers, 1912. Compiled and published by The Cement Era, 1207 Morton Building, Chicago. Price $1.

CATALOGUES RECEIVED.

Excavators. The F. C. Austin Drainage Excavating Company, Railway Exchange Building, Chicago, Ill., manufacturers of irrigation and drainage excavating machinery, forward catalogue showing different machines in operation.

The Tromanhauser System of Sub-Aqueuous Concrete Construction. By J. H. Tromanhauser, engineer and contractor, Temple Building, Toronto, describes his patented method of floating pontoon system of concrete construction in a pamphlet printed by the Canadian Engineer Press.

Compressors, Air and Gas. Catalogue issued by the Canadian Rand Company, Ltd., Montreal, Canada, describing their different types of compressors.

Ignition Appliances and Auto Accessories. Supply catalogue issued by the Canadian General Electric Company, Ltd., Toronto, Canada.

Steam Tables for Condenser Work. Issued by The Wheeler Condenser and Engineering Company, of Carteret, N.J.

Pneumatic Tools. A series of pamphlets issued by the Chicago Pneumatic Tool Company, of Chicago, describing their different types of pneumatic tools, air compressors, hoists, electrical drills, etc.

The Best Manufacturing Company, Pittsburg, Pa., forward catalogue and hand-book of piping materials for steam, air, hydraulic, high-pressure piping systems.

Expanded Metal Constructiotn. Pamphlet No. 1, issued by the Northwestern Expanded Metal Company, Chicago, Ill.

Intermittent Flush Tanks. Pamphlet issued by the Pacific Flush Tank Company, Chicago and New York, describing their automotic, intermittent flush tank syphons.

Corrugated Bar Company, Buffalo, forward pamphlets describing the different materials fabricated by them and giving data useful in design.

Ferro Engines. Published by the Ferro Machine and Foundry Company, Cleveland, O.

Engineers' and Surveyors' Instruments. Catalogue L 112, of E. R. Watts & Sons, Ottawa and Winnipeg. Catalogue of engineers, surveyors, architects and draughtsmen's instruments and supplies.

Catalogue No. 50, The H. Shannon Company, Chicago, machinery and general supplies.

Description Leaflet No. 2298 of The Westinghouse Electric and Manufacturing Company, describing its well-known type CCL Inductor Motor.

Leaflet No. 2330 of the Westinghouse Electric and Manufacturing Company, covering a direct-current (type JL) vertical edgewise switchboard ammeter operating on the D'Arsonval principle with a single air-gap.

NATIONAL ASSOCIATION OF CEMENT USERS.

Eighth Annual Convention.

On March 11-16, 1912, the association will meet in its eighth annual convention, at Kansas City, Mo. The first Kansas City Cement Show will be held March 14-21, under the auspices of the Cement Products Exhibition Company.

The headquarters and convention will be at the Hotel Baltimore, where each member must go to register and secure information on all matters pertaining to the convention and Cement Show.

Tentative Program.—Monday, March 11.

10.30 a.m.—Meeting of the Executive Board, Hotel Baltimore.

2.00 p.m.—Meeting of Sectional Committees on: Building Blocks and Cement Products; Exhibition; Fireproofing; Insurance; Measuring Concrete; Nomenclature; Reinforced Concrete and Building Laws; Roadways, Sidewalks, and Floors; Specifications and Methods of Tests for Concrete Materials; Treatment of Concrete Surfaces; Education.

8.00 p.m.—Formal opening of the convention, Hotel Baltimore. Address of welcome to Kansas City. Response by the president, Richard L. Humphrey, consulting engineer, Philadelphia, Pa. Address. Address. Business session. Reinforced Concrete Water Purification Works, Dr. Walter M. Cross, city chemist, Kansas City, Mo.

Tuesday, March 12.

9.00 a.m.—Meeting of the Sections on Measuring Concrete, Nomenclature, and Specifications and Methods of Tests for Concrete Materials. Topical discussion on Methods of Measuring Concrete Construction, and on Materials Used for Concrete.

10.30 a.m.—Report of the Committee on Measuring Concrete, Robert A. Cummings, chairman. Report of the Committee on Nomenclature, Peter Gillespie, chairman. Report of Committee on Specifications and Methods of Tests for Concrete Materials, Sanford E. Thompson, chairman. Discussion on Aggregates for Concrete, Wm. M. Kinney, assistant inspecting engineer, Universal Portland Cement Co., Pittsburg, Pa. Discussion on the Use of Calcium Chloride as a Preventive of the Freezing of Concrete, Richard K. Meade, chief engineer, Tidewater Portland Cement Company, Baltimore, Md. Report of the Committee on Fireproofing, Rudolph P. Miller, chairman.

8.00 p.m.—Annual address by the president, Richard L. Humphrey, consulting engineer, Philadelphia, Pa., Construction of the Hollow Reinforced Concrete Dam of the Portland Railway Light and Power Company, Robert S. Edwards, consulting engineer, Portland, Oregon. Discussion of the Advantages and Comparative Cost of the Hollow Concrete Dam, W. L. Church, president, Ambursen Hydraulic Construction Company, Boston, Mass. The Design and Construction of the Keokuk Dam, Hugh L. Cooper, chief engineer, Mississippi River Power Company, Keokuk, Iowa. Report of the Committee on Insurance, W. H. Ham, chairman. Report of the Committee on Treatment of Concrete Surfaces, L. C. Wason, chairman.

Wednesday, March 13.

9.00 a.m.—Meeting of the Section on Reinforced Concrete and Building Laws. General discussion on Design, Methods of Construction, etc.

10.30 a.m.—Report of the Committee on Reinforced Concrete and Building Laws, A. E. Lindau, chairman. The Design of Concrete Flat Slabs, F. J. Trelease, Engineer, Corrugated Bar Company, Buffalo, N.Y. Business session: Report of the Executive Board; election of officers; place of next convention.

3.00 p.m.—The Control Beam as a Field Test for Concrete, Fritz E. von Emperger, consulting engineer, Vienna, Austria. Notes on the Deformation in the Webs of Rectangular Concrete Beams, H. C. Berry, assistant professor of materials of construction, University of Pennsylvania, Philadelphia, Pa. Continuous Concrete Beams, Dr. E. Probst, consulting engineer, professor, Royal Technical High School, Berlin. The Construction of the Fireproof Type of School House with Separately Molded Members, Theodore H. Skinner, architect, Oneida Community, Ltd., Oneida, N.Y. Unit Cost of Reinforced Concrete for Industrial Buildings, F. W. Reynolds, Lockwood, Greene and Company, Boston, Mass.

8.00 p.m.—Methods of Construction Used in the Arbuckle Building, Brooklyn, R. C. Wilson, assistant engineer, Turner Construction Company, New York, N.Y. The Design and Construction of a Reinforced Concrete Dome, 220-foot span, Dr. S. J. Trauer, chief engineer, Breslau, Germany. The Design of Reinforced Concrete Domes, H. Brussel, president, Reinforced Concrete Company, St. Louis, Mo. The Design of Concrete Grain Elevators, E. Lee Heidenreich, consulting engineer, Kansas City, Mo. The Construction of Concrete Grain Elevators, John S. Metcalf, consulting engineer, Chicago, Ill. Reinforced Concrete Grain Elevators and Silos, M. S. Ketchum, consulting engineer, Boulder, Col. The Use of Concrete in the Fourth Avenue Subway, Brooklyn, Frederick C. Noble, division engineer, Public Service Commission, Brooklyn, N.Y.

Thursday, March 14.

9.00 a.m.—Meeting of Section on Treatment of Concrete Surfaces. Topical discussion on the Artistic Treatment of Concrete Surfaces.

10.30 a.m.—Concrete Highway Bridges, Walter Scott Gearhart, State Highway Engineer, Extension Department, Agricultural College, Manhattan, Kansas. The Dallas Oak Cliffe Viaduct, Ira G. Hedrick, consulting engineer, Kansas City, Mo. Flat Slab Bridges, W. H. Finley, assistant chief engineer, Chicago and Northwestern Railroad, Chicago, Ill. The Use of Cement for Protecting the Steel Pipes Along the New York Aqueduct, Alfred D. Flinn, department engineer, Board of Water Supply, New York, N.Y.

8.00 p.m.—The Necessity for Good Roads, Logan Waller Page, director, Office of Public Roads, president, American Good Roads Association, Washington, D.C. Cement Paving as Constructed at Mason City, Iowa, F. P. Wilson, city engineer, Mason City, Iowa. An Improved Concrete Pavement, E. W. Groves, city engineer, Ann Arbor, Mich. Concrete and Highway Construction. Report of Committee on Roadways, Sidewalks and Floors, C. W. Boynton, chairman. Report of Committee on Education, Logan Waller Page, chairman.

Friday, March 15.

9.00 a.m.—Meeting of the Section on Roadways, Sidewalks and Floors. Topical discussion covering the Preparation of Materials, Laying, Finishing, Costs.

10.30 a.m.—Report of Committee on Building Blocks and Cement Products, P. S. Hudson, chairman. Advantages and Durability of Cement Sewer Pipe, Gustave Kaufman, engineer, The Wilson and Baillie Manufacturing Company, Brooklyn, N.Y. Cement Drain Tile, A. Marsten, Dean School of Engineering, Iowa State College, Ames, Iowa. The Manufacture and Use of Cement Drain Tile, Charles T. Sims, Worthington, Minn. Methods of Testing Cement Pipe, Duff A. Abrams, assistant professor, University of Illinois, Urbana, Ill.

8.00 p.m.—Reception and banquet, Hotel Baltimore.

Saturday, March 16.

9.00 a.m.—Meeting of the Section on Building Blocks and Cement Products. Topical discussion on the Manufacture, Curing, Cost, etc., of Cement Products.

10.30 a.m.—Concrete Fence Posts, W. J. Towne, engineer of maintenance, Chicago and Northwestern Railroad, Chicago, Ill. Some Notes on the Value and Comparative Cost of Reinforced Concrete Telegraph Poles, George Gibbs, chief engineer of construction, Pennsylvania Railroad, New York, N.Y. Concrete Piles and Harbor Work, Dmitri Alexeev, engineer, Russian Northern Railway, Moscow, Russia. Reinforced Concrete Piles, Robert A. Cummings, consulting engineer, Pittsburg, Pa. The Concrete Block Industry in Russia, Alexander Zuberbuhler, engineer, Moscow, Russia. Modern Methods of Manufacturing Concrete Products, Robert F. Havlik, engineer, Ideal Concrete Machinery Company, South Bend, Ind.

8.00 p.m.—The Use of Concrete in Irrigation Work, F. H. Newell, chief director, U.S. Reclamation Service, Washington, D.C. Reinforced Concrete in Agriculture, W. A. Collings, engineer, Builders' Material Supply Company, Kansas City, Mo. The Handling of Concrete in the Construction of the Panama Canal, S. B. Williamson, engineer, Pacific Division, Panama. Iron Portland Cement.

ENGINEERING NOTES.

Guelph, Ont.—Messrs. McArthur Bros., of New York, U.S.A., are contemplating the building of the Hamilton, Waterloo and Guelph Railway. They are waiting on certain engineering reports now being prepared.

Lethbridge, Alta.—The M. Rumley Co., of La Porte, Ind., will donate a 30 horse-power oil traction engine to the farmer exhibiting the best bushel of hard wheat at the Dry-Farmed Exhibition to be held at this point on October 21-26 next. The contest is open to farmers of every land.

Halifax, N.S.—Negotiations now in progress between the government and certain Canadian and English transportation companies operating trans-Atlantic steamship lines will result, if successful, in the establishment of a new fast service between Canada and England The proposal will make Halifax the Canadian terminal.

Glasgow, Scotland.—The street railway systems of the cities of Glasgow and Leeds are the two most successful municipally owned street railways in the old country, if not in the world. In each case the railway is the owner of its own power stations, distinct from whatever other electrical plants the city may own, and they manufacture only their own energy, no power being taken from them for any other purpose.

Vancouver, B.C.—In order to stimulate interest in good roads throughout Canada, W. J. Kerr, president of the Canadian Highway Association, is offering three medals for the best essay on "What Good Roads Mean to Canada." The competition for these medals is to be confined to boys and girls under 18 years of age, and no distinction is to be made between the sexes. Women have long since taken a place in literature equal to that occupied by men, Mr. Kerr believes, and a contest in which girls will compete against boys will be more interesting to all concerned than one in which separate prizes are given. The competition will be open to students in all parts of Canada, and there will be no hard and fast rules as to the length of the essay submitted, although articles of 800 to 1,000 words will be preferred. All essays must be in the hands of the secretary, P. W. Luce, 614 Columbia Street, New Westminster, B.C., on or before May 1st, 1912.

Magdalene Islands, Eastern Canada.—These islands, which lie directly south-east of the Gaspe peninsula, in the Gulf of St. Lawrence, and which in the past have been cut off from communication with the outside world during the winter months by the ice fields which bridge them from the main land, for a distance of more than 100 miles, will in the future be provided with a weekly news letter by wireless. For the sum of $450 the government has arranged with the Marconi Wireless Company whereby a wireless message of 1,000 words will be sent to the islands every Saturday evening, containing in brief the most important happenings of the world. Upon reaching the islands this news will be sent to the various clergymen, and will be read from the pulpits of the churches on Sunday.

PERSONAL.

Mr. Thomas H. Mawson has been appointed by the city of Vancouver to lay out Stanley Park, 900 acres in extent. Mr. Mawson is an English landscape artist.

Mr. Clifford Richardson, M.Am.Soc.C.E., Consulting Engineer, New York City, on February 16th, delivered a lecture on "Trinidad and Bermudez Asphalts and Their Use in Highway Construction," before the Graduate Students in Highway Engineering at Columbia University.

Mr. E. C. Hewson has been appointed to the position of resident engineer for the Grand Trunk Railway at Toronto. Mr. Hewson has been Mr. Power's assistant for nearly three years, and, before entering the service of the G.T.R. was engaged on various engineering works for the Dominion Government.

OBITUARY.

Francis H. Stillman, president of the Watson-Stillman Company, and a prominent figure in machine tool and engineering industries, died at his residence, 105 Rodney Street, Brooklyn, N.Y., in his sixty-second year.

MEETINGS.

Mr. H. H. Hagerman addressed the Engineering Society of the University of New Brunswick, on the "Bacteria and Their Relation to Water."

ONTARIO LAND SURVEYORS' RESULTS.

The following have been granted certificates as Ontario land surveyors by the Board of Examiners: Messrs. W. L. Malcolm, W. A. Sibbett, F. V. Siebert, W. C. Webster, W. J. Baird, G. Hogarth, J. M. McGregor, O. R. Blandy, F. C. Lane, R. M. Gourlay, M. C. Lloyd, W. S. Earle, M. M. Gibson, J. C. Street.

The following passed the preliminary examination: Messrs. V. H. Ramsden, A. L. Stanley Nash, C. J. Manser, N. J. Goebel, R. O. Sturdy.

COMING MEETINGS.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS — Toronto Section. Regular Meeting will be held at Engineers' Club, 96 King Street West, on Friday evening, March 1st, 1912, at 8 p.m. Illustrated paper on "The Shawinigan Water and Power Co.'s New Power House and 110,000 Volt Transmission to Montreal," by Mr. Julian C. Smith, Chief Engineer of the Shawinigan Water and Power Co. Secretary, Valentine Boyd.

THE CANADIAN MINING INSTITUTE.—Annual Meeting held in Toronto, March 6th, 7th, and 8th, 1912, the American Institute of Mining Engineers co-operating; also important delegates of the Institute of Mining and Metallurgy of Great Britain will be present. Secretary, H. Mortimer-Lamb.

ONTARIO GOOD ROADS ASSOCIATION.—Annual Convention to be held at Toronto, February 26, 27, 28. Secretary, J. E. Farewell, Whitby.

ASSOCIATION OF ONTARIO LAND SURVEYORS.—Annual Meeting to be held in Lecture Room, Engineers' Club, 96 King Street West, Toronto, on Feb. 27, 28 and 29. Secretary, Killaly Gamble, 703 Temple Bldg., Toronto

THE ENGINEERS' CLUB OF TORONTO, 90-96 King St. West.—Thursday, Feb. 29th, 8 p.m. Meeting of Toronto Branch of Canadian Society of Civil Engineers. R. B. Wolsey, Secretary.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—**President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.**

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—**President, G. M. Lang;** Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—**President, J. L. R. Parsons, Regina;** Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—**President, N. McMurchy;** Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—**President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.**

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, **Canadian Electrical News, Toronto.**

CANADIAN FORESTRY ASSOCIATION—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President. Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary, H **Mortimer-Lamb, Windsor Hotel, Montreal.**

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, **409 Union Station. Meets third Tuesday each month except June, July, August.**

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, **A. McQueen.**

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, **R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.**

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; **Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.**

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. **Canadian Members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W. H. Trewartha-James and J. B. Tyrrell.**

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary, R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, **C. G. Chataway, Winnipeg, Man.**

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, **A. A. Hayward.**

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, **J. E. Farewell, Whitby.**

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, **Killaly Gamble, 703 Temple Building, Toronto.**

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, **Toronto, Secretary.**

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
2-26	75,000 gallon water tank, Moose Jaw, Sask. (S.)	2- 8
3- 8	Water Tube Boilers; Automatic Stokers; Turbines; Saskatoon, Sask. (S.)	2-15
3-18	Concrete reservoir (2,000,000 gallons' capacity), Moose Jaw, Sask. (P. & S.)	2-22
3-18	Centrifugal pumps, motors, etc., Moose Jaw, Sask. (P. & S.)	2-22
3-18	Valves and Fittings, Moose Jaw, Sask. (P. & S.)	2-22
3-18	96,000 ft. of 18-in. Steel Pipe, Moose Jaw, Sask. (S.)	2-22
3-15	Pavements, Welland, Ont. (P. & S.)	2-29

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Brantford, Ont., sewer pipe	Feb. 29.	Feb. 22.	72
Calgary, Alta., designs for aqueduct	May 1.	Feb. 22.	70
Calgary, Alta., electric machinery	Mar. 20.	Feb. 8.	68
Calgary, Alta., sluice gates	Feb. 29.	Feb. 1.	68
Edmonds, B.C., steel pipes	Mar. 11.	Feb. 8.	68
Edmonton, Alta., steel highway Bridges	Mar. 15.	Feb. 22.	59
Edmonton, Alta., office building for C.P.R.	Mar. 1.	Feb. 22.	60
Hamilton, Ont., waterworks extensions	Feb. 28.	Feb. 15.	68
Keremos, B.C., quarantine station	Mar. 1.	Feb. 8.	59
Kingston, Ont., dormitory, R.M.C.	Mar. 6.	Feb. 22.	59
Milton, Ont., concrete arch and viaduct	Mar. 4.	Feb. 15.	70
Moose Jaw, Sask., reservoir	Mar. 18.	Feb. 22.	66
Moose Jaw, Sask., pumps, motors, etc.	Mar. 18.	Feb. 22.	66
Moose Jaw, Sask., valves and fittings	Mar. 18.	Feb. 22.	66
Moose Jaw, Sask., laying steel water pipe	Mar. 18.	Feb. 22.	66
New Westminster, B.C., dams and excavation work	Mar. 10.	Feb. 15.	59
Ottawa, Ont., steel hopper scows	Mar. 11.	Feb. 22.	59
Saskatoon, Sask., waterworks materials	Mar. 1.	Feb. 15.	68
Saskatoon, Sask., electrical machinery	Mar. 8.	Feb. 15.	68
Sault Ste. Marie, Ont., approach to wharf	Feb. 28.	Feb. 15.	59
Swan River, Man., schoolhouse	Feb. 29.	Feb. 15.	60
St. Andrew's, N.B., school house	Mar. 11,	Feb. 22.	60
St. Catharines, Ont., church	Mar. 12.	Feb. 22.	60
St. Catharines, Ont., crushed stone	Feb. 28.	Feb. 22.	70
Toronto, Ont., bridges	Mar. 2.	Feb. 1.	59
Toronto, Ont., sewer, Toronto Junction	Feb. 27.	Feb. 8.	68
Toronto, Ont., annual supply of asphalt	Feb. 27.	Feb. 15.	70
Toronto, Ont., Coxwell Ave. subway	Mar. 7.	Feb. 15.	70
Toronto, Ont., Barton Ave., sewer	Mar. 12.	Feb. 22.	72
Vernon, B.C., vitrified pipe sewers	Mar. 11.	Feb. 22.	60
Victoria, B.C., St. John's Church edifice	Mar. 5.	Feb. 15.	60
Westmount, Que., sewer, paving	Mar. 11.	Feb. 22.	70
Winnipeg, Man., gate valves	Mar. 7.	Feb. 22.	60
White Rock, B.C., quarantine station	Mar. 15.	Feb. 15.	59
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., pumping machinery	Mar. 1.	Jan. 25.	72
Winnipeg, Man., steam shovel equipment	Mar. 1.	Feb. 15.	60
Winnipeg, Man., cables	Mar. 25.	Feb. 15.	60
Winnipeg, Man., waterworks materials	Mar. 1.	Feb. 15.	60

TENDERS.

Calgary, Alta.—The time for receiving tenders for electrical machinery has been extended to March 20th, 1912. J. M. Miller, City Clerk, Calgary. (See advertisement in Canadian Engineer).

Calgary, Alta.—Tenders will be received up to noon, March 6th, 1912, for the construction of various municipal works, such as concrete sidewalks, asphalt, bitulithics and block pavements, specifications of which may be obtained at the office of the City Commissioners or City Engineer, City Hall, Calgary. J. M. Miller, City Clerk.

Calgary, Alta.—The Calgary College will erect an Arts Building, costing about $500,000, and the Building Committee invites sketch plans. Full particulars, W. J. Tregillus, secretary, Calgary, Alta.

Calgary, Alta.—Tenders will be received by the Commissioners of the city of Calgary for one boiler feed pump and switchboards for the city of Calgary municipal electric light and power plant, until noon, March 15th, 1912. Specifications can be secured by application at the office of the city commissioners. J. M. Miller, City Clerk, Calgary.

Calgary, Alta.—Tenders will be received until March 14, 1912, for the supplying the city with sewer and conduit pipe, to be delivered at the city yards in carload lots as may be required. Specifications may be secured upon application at the office of the city engineer. J. M. Miller, City Clerk, Calgary.

Fort William, Ont.—Tenders will be received at the office of the City Clerk, until the 7th day of March, 1912, for the laying of an eighteen (18) cast iron main and the construction of a concrete culvert. Plans, etc., at the office of John Wilson, City Engineer.

Fredericton, N.B.—Tenders are being called for the construction of the concrete substructure and approaches of the Heine bridge, over Millstream, King's County; the Murchie bridge, over the Madawaska River, at Edmundston, and the Bocaguimac Mouth bridge, at Hartland. The plans and specifications can be seen at the office of Public Works Department, and tenders for the work will be received until April 1st.

High River, Alta.—Tenders will be received at the office of the Secretary of the High River school district No. 144, until March 15th, 1912, for the erection and completion of a four-roomed brick schoolhouse. Plans and specifications at office of Norman Young, Secretary, High River.

High River, Alta.—Tenders will be received until March 15th, 1912, for the heating, ventilating and plumbing of a four-roomed brick schoolhouse, as per plans and specifications on file at office of the Secretary, Norman Young, High River, Alta.

North Battleford, Sask.—Plans and specifications will be received for the erection of a Collegiate Institute in the town of North Battleford, Sask. The building to be erected is to cost from $50,000 to $80,000 complete, designs to be in the hands of the secretary by the 1st of March, 1912, or as soon after as possible. Hugh Moher, secretary-treasurer, North Battleford High School District, No. 12.

Oshawa, Ont.—Tenders will be received until March 11th, 1912, for the construction of a brick or asphalt block pavement, on a concrete base, together with a cement concrete curb and gutter, approximately 25,000 sq. yards. Plans and specifications obtained at the office of Frank Chappell, Town Engineer, Town Hall, Oshawa. (See advertisement in Canadian Engineer).

Ottawa, Ont.—Tenders will be received until the 15th of March, 1912, for the erection of a new brick veneer presbytery at South Gloucester. For plans and specifications apply to Rev. Geo. Prudhomme, South Gloucester, Ont.

Ottawa, Ont.—Tenders will be received until March 6th, 1912, for the supply of coal and fuel wood required to heat the Military Buildings at Halifax, Canning, N.S.; Fredericton, Woodstock, Sussex, Chatham, St. John, N.B.; Charlottetown, P.E.I.; for the year ending March 31st, 1913. Eugene Fiset, Col. Deputy-Minister of Militia and Defence, Ottawa.

Ottawa, Ont.—Tenders will be received until March 11, 1912, for the construction of two 150 cubic yards capacity steel hopper scows. R. C. Desrochers, Secretary, Dept. of Public Works, Ottawa. (See advt. in Can. Eng.)

Ottawa, Ont.—Tenders for the construction of a breakwater at Green Point, Gloucester County, N.B., will be received until March 18, 1912. Plans, etc., can be seen at the offices of Geoffrey Stead, Esq., Dist. Engineer, Chatham, N.B.; E. T. P. Shewen, Esq., Dist. Engineer, St. John, N.B.; on application to the Postmaster at Green Point, Gloucester County, N.B., and the office of R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Prince Albert, Sask.—Tenders will be received until Friday, March 15th, 1912, for the supplying of sewer pipe required by the city during the year 1912. C. O. Davidson, Sec.-Treas., Prince Albert, Sask. (See advt. in Can. Eng.)

Prince Albert, Sask.—Tenders will be received by the City Commissioners, until March 8th, 1912, for the supplying of cast-iron water pipe required by the city during the year 1912. C. O. Davidson, secretary-treasurer, Prince Albert. (See advertisement in Canadian Engineer).

Regina, Sask.—Tenders will be received up to noon, March 4th, at the offices of F. Chapman Clemesha, architect, Regina, for the erection of a brick Presbyterian church at Swift Current, Sask.

Saskatoon, Sask.—Tenders for the supplying of approximately 5,000 barrels of Portland Cement will be received until Friday, March 15th, 1912. All information obtained on application to Geo. T. Clark, City Engineer, Saskatoon. (See advertisement in Canadian Engineer).

Saskatoon, Sask.—The time for receiving tenders for electrical machinery has been extended to March 22nd, 1912. City Commissioners, Saskatoon, Sask. (See advertisement in Canadian Engineer).

Saskatoon, Sask.—Tenders will be received until March 8th, 1912, for all trades required for the completion of the superstructure of the Y.M.C.A. Building, Saskatoon. Plumbing and heating to be separate, and will be received at the same time. Plans and specifications may be seen at the office of D. W. F. Nichols, Winnipeg, Thompson, Daniel & Colthurst, Associate Architects, Saskatoon.

Saskatoon, Sask.—Tenders will be received until March 29th, 1912, for the laying of approximately 8,990 lineal feet of storm sewers, and the construction of manholes, catch basins and appurtenances. All information may be obtained from Geo. T. Clark, City Engineer, Saskatoon. (See advt. in Canadian Engineer).

Saskatoon, Sask.—Tenders will be received by the City Commissioners until March 29th, 1912, for the laying of approximately 13 miles of sanitary sewer and water mains, and the construction of all necessary manholes and flush-tanks, setting of fire hydrants and gate valves, etc., as shown on plans and profiles, and according to specifications. Further information may be obtained at the office of Geo. T. Clark, City Engineer. (See advt. in Canadian Engineer).

Sydney Mines, C.B.—Tenders will be received until March 2nd, for the erection and completion of an annex to "Harbor View Hospital," Sydney Mines. Plans and specifications can be seen at the general office of the N.S.S. & C. Co., and at the Town Engineer's office, Sydney Mines. Edmund MacDonald, Secretary to Trustees, Harbor View Hospital, Sydney Mines, C.B.

Toronto, Ont.—Tenders will be received by the chairman of the Board of Control until March 19, 1912, for the supply of rails, ties and fastenings, specifications and forms of tender of which may be obtained on application to the Dept. of Railways and Bridges, City Engineer's Office, Toronto. (See advt. in Can. Eng.)

Toronto, Ont.—Tenders for the construction of the proposed branch of the Temiskaming Railway into the Elk Lake region, will be called for shortly.

Vancouver, B.C.—Tenders will be received for the supply of hydrants and water pipe, for the proposed extensions to the water works distribution system, during the current year. Tenders for hydrants will be received up to Wednesday, March 6th, 1912, and tenders for pipe will be received up to Wednesday, March 20th, 1912. Specifications may be seen at the City Engineer's Office, City Hall. Wm. McQueen, City Clerk, City Hall, Vancouver, B.C.

Welland, Ont.—Tenders are invited for the construction of approximately 37,000 square yards of pavement, in vitrified brick, bitulithic, asphalt block, or granitoid. Plans, etc., on file at the office of The Canadian Engineer, 62 Church Street, Toronto, or at the Town Engineer's office, Welland. (See advertisement in Canadian Engineer).

CONTRACTS AWARDED.

Calgary, Alta.—The contract for the building of the new Knox Presbyterian church is in the hands of Messrs. Fysche, Martin Co., Ltd. The contract, exclusive of value of lots, excavation, organ, pews or furnishings, will be $183,000.

Calgary, Alta.—Messrs. P. Lyall & Sons Construction Company, of Montreal, have secured the contract for the new big C.P.R. hotel here.

Calgary, Alta.—The Westinghouse Church, Keer & Company, of Pittsburg, Pa., will build for the Canadian Pacific Railway Company, additional railway shops at a cost of $2,750,000. Construction will start shortly. Contract includes the design and construction of locomotive, machine, boiler, blacksmith, pattern, coach and freight car repair and paint shops, foundry, planing mill, power house, dry kiln, scrap docks, material bins, store room and office buildings. In general the construction will be of concrete, steel, brick or hollow tile.

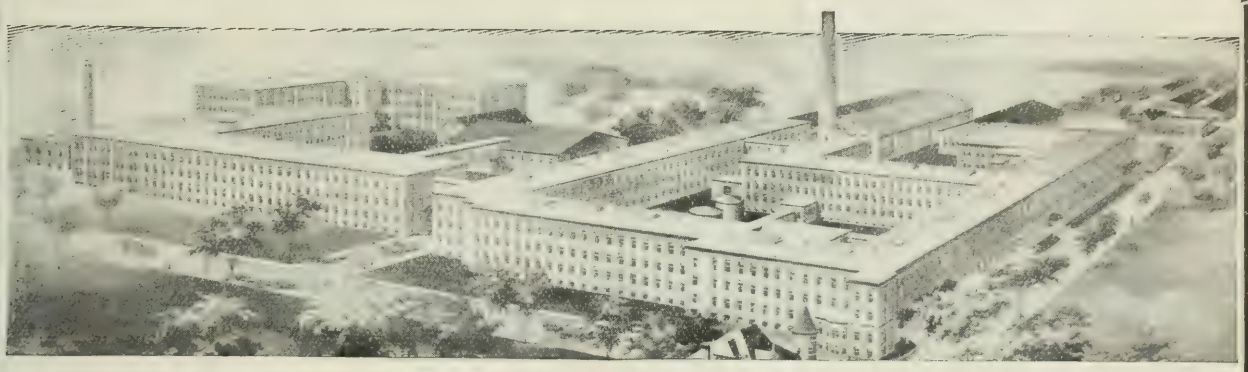
Hamilton, Ont.—The Hamilton Bridge Works, Hamilton, Ont., have awarded the contract for two overhead traveling cranes of 30 tons lifting capacity and approximately 60 ft. span, and for two overhead traveling cranes of 10 tons lifting capacity and approximately 90 ft. span, to Messrs. Royce, Limited, of Manchester, England. Mr. C. S. Mallett, of 207 Lumsden Building, Toronto, the Canadian manager for Messrs. Royce, Limited, also announces the award to his company of a contract for supplying the Jenckes Machine Company with an overhead traveling crane of 5 tons lifting capacity and 41 ft. span, for the Sherbrooke shops; and an overhead traveling crane of 10 tons lifting capacity and 48 ft. span, for the St. Catharines, Ont., shops.

Montreal.—The Foundation Company, Limited, of Montreal and Winnipeg, have been awarded the contract for the new substructure in connection with the double-tracking of the C.P.R. Red River bridge at Winnipeg. The work consists of five river piers and two abutments.

Moose Jaw, Sask.—The contract for the erection of the Boys' College building and the principal's residence in connection with Saskatchewan College, in this city, has been awarded to Claydon Bros., of Winnipeg, Man.

North Burnaby, B.C.—Messrs. Mussens, Ltd., have received the contract to supply a rock crushing plant at a cost of $2,568.20. It is being ordered by the council of Edmonds, Burnaby.

Barrett Specification Roofs



Warner Bros. Co., Corset Manufacturers, Bridgeport, Conn. Day & Zimmerman, Engineers, Philadelphia, Pa.

The Most Economical Roof

FOR half a century architects have known that slag and gravel roofs would *often* show marvelous durability.

The Barrett Specification defines the method by which these roofs may be built so that they will *always* show such durability.

It provides for the best materials manufactured, and prescribes the most approved methods of application.

A Barrett Specification Roof will cost less than any other permanent roof, will last upwards of twenty years and will need no painting or coating or care. Such roofs are fire-retardant and take the base rate of insurance.

That is why they are invariably used on large manufacturing plants where the roof areas are great and where, therefore, the unit costs are carefully studied.

Booklet giving the Barrett Specification in full mailed free on request. Address nearest office.

Special Note

We advise incorporating in plans the full wording of The Barrett Specification, in order to avoid any misunderstanding.

If an abbreviated form is desired however the following is suggested:

ROOFING—Shall be a Barrett Specification Roof laid as directed in printed Specification, revised August 15th, 1911, using the materials specified, and subject to the inspection requirement.

The Paterson Manufacturing Co., Limited

Montreal Toronto Winnipeg Vancouver St. John, N.B. Halifax, N.S.

Saskatoon, Sask.—The Bithulithic Paving Company have been awarded the contract for 63,000 square yards of the 125,000 sq. yards of paving to be done this season. The tender of this company was for $2.95 per square yard.

Seven Falls, P.Q.—The Ambursen Hydraulic Company of Montreal, have been awarded the contract for the construction of a 10,000 horse-power development on the St. Anne River.

Suffield, Alta. — J. G. Hargrave & Company, Ltd., of Winnipeg, have received a contract from the C.P.R. for earthwork and embankments on the new branch from Suffield, Alta., from the main line in a south-westerly direction. The work will be started in April after the completion of similar work at Bassano.

Victoria, B.C.—Messrs. Moore & Whittington, builders and contractors, are building a three-story, brick apartment house at the junction of Fort and Pandora Streets. The expenditure contemplated is $25,000.

Vancouver, B.C.—A contract to the value of about $200,000 was awarded to the B.C. Equipment Company, of Vancouver, for combined gravel washing and rock crushing plants at Cragilacchie, Trail Creek and Old Man Creek. Each of these plants are capable of washing out a thousand yards daily. The gravel will be used for concrete culverts and the rock for ballast.

RAILWAYS—STEAM AND ELECTRIC.

British Columbia.—The promoters of the British Columbia and Alaska Railway announce their intention of renewing work in the spring of 1912. Mr. E. C. Harris, of New York, the new president of the company, was for some time assistant engineer of the Chicago, Milwaukee and St. Paul, and later having served as general manager of the Santa Fe road.

Fredericton, N.B.—Mr. Frank de L. Clements is interested in a proposed electric line from this point to Springhill, a distance of five miles. The proposition is to purchase a storage battery car and secure running rights over the St. John Valley Railway rails, giving a service at regular intervals throughout the day. A car such as proposed would cost about $12,000, and it is expected to have the service in operation by some time next summer.

Halifax, N.S.—Mr. C. C. Longard has prepared a sketch showing proposed improvements to the railway station in this city.

North Toronto, Ont.—A proposed electric line, known as the Forest Hill Electric Railway Company, contemplate building a line in these parts.

Ottawa, Ont.—City Engineer, Mr. N. J. Ker, has prepared plans for an extension of the street railway lines. The extension will total six and a half miles.

Prince Edward Island.—The Federal Government contemplate spending $450,000 on a car ferry, $400,000 on increasing the gauge of the P.E.I. Railway, and $490,000 on the construction of a third rail. This work is all for the benefit of the P.E.I. Railway.

Province of Saskatchewan.—The Grand Trunk Pacific Railway contemplate opening forty-seven new towns. A contract has been awarded to a Minnesota firm to construct twenty-five general stores throughout these towns.

Vancouver, B.C.—The work of filling in the Great Northern Railways right-of-way on False Creek is to be started in the course of the next few weeks. Three or four million yards of earth will be required.

Vernon, B.C. — A Canadian Northern Railway survey party of 12 men in charge of A. E. Ashcroft, C.E., will begin work on the location of the proposed branch line from Vernon to Kamloops. At the latter point connection will be made with the company's main line. The distance between Vernon and Kamloops is about eighty miles, and it is expected that an easy grade will be secured although there will be a short stretch of heavy work at the summit.

COPY OF ENGINEER WANTED.

A copy of our issue of August 10, 1911, is required. Parties sending in the same will have the expiration date of their subscription advanced one month.

LIGHT, HEAT AND POWER.

Acton, Ont.—The ratepayers voted in favor of adopting the hydro-electric policy and to issue debentures for $8,500 to equip the municipal line for hydro-power. A. J. Mackinnon, Town Clerk.

Brantford, Ont.—Certain improvements being made to the plant of the Waterous Engine Works will necessitate a new power plant installation.

Fredericton, N.B.—A survey of the Boccaguimaca stream has been made for power purposes.

Niagara Falls, Ont.—A report indicates that extensive additions to the plant of the Electrical Development Company will be made. The powerhouse is to be extended to the south, the addition to be erected costing over $200,000. Four more power units are to be installed, increasing the power development from 80,000 to 120,000 horsepower, and the transmission line to Toronto will likely be duplicated. Altogether a sum of about $1,000,000 will be spent by the company on the contemplated improvements.

Porcupine, Ont. — The management of the McIntyre, Hollinger and Dome mines are preparing to install electric motors in their mills.

Smith's Falls, Ont.—Mr. Acres and Mr. Gates have been in Smith's Falls in connection with the Hydro-Electric Commission, to make a thorough inspection of the water powers, the electric light and power plants, the pumping station, and the topography of the town and will make a report to the commission on their findings. The probable source of supply is Chats Falls.

GARBAGE, SEWAGE AND WATER.

Halifax, N.S.—Mr. F. W. W. Doane, municipal engineer of this city, has prepared a report covering proposed changes in the waterworks system. In this he recommends the construction of two reservoirs and other works costing $100,000.

Ottawa, Ont.—The municipal council have been asked to construct a septic tank for the treatment of sewage to cost $6,000. N. J. Ker, City Engineer.

Province of Ontario.—The Provincial Board of Health will shortly serve notice on municipalities to cease contaminating the navigable streams of the province by pouring sewage into them. At present, no municipality in Ontario is allowed to extend its sewage system without special permission from the provincial board.

Regina, Sask.—An extension programme of sewer extensions will be carried through to completion during the present year, if at all possible. To expedite the completion of the work it is proposed to divide the various undertakings into separate contracts.

Toronto, Ont.—The municipal council voted in favor of spending $100,000 on water meters.

Westmount, Montreal, P.Q.—The assessment of the city of Westmount is being sued before the courts, by the Montreal Water and Power Company. The allegation is that the assessors do not give to real estate its real value, being as a rule, about ten per cent. below the level. The contention is denied by the officials of the city, and the facts are being argued upon in the Circuit Court, before Mr. Justice Dorion. The argument of the Montreal Water and Power Company is that payment of the water rates in Westmount is based on the valuation of property and that by undervaluing real estate in their assessment, the assessors affect the income of the company.

Winnipeg, Man.—Acting City Engineer Wilson will prepare plans for a water supply to be obtained from Poplar Springs.

BUILDINGS AND INDUSTRIAL WORKS.

Berlin, Ont.—The municipal authorities are taking steps toward the erection of a tubercular sanitarium to cost $1,500. A. H. Miller, Town Clerk.

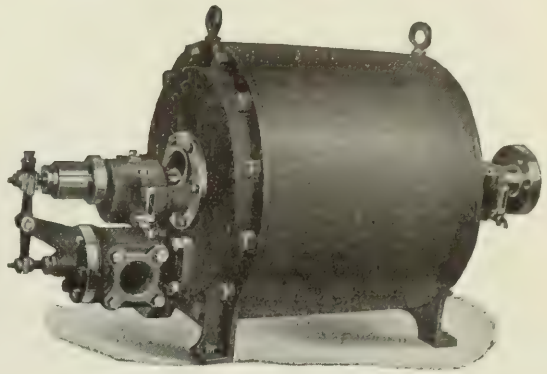
Brampton, Ont.—A report states that the Pease Foundry Company, now located at Toronto, will remove to this point. They intend erecting a large plant to employ 100 men.

Kerr Turbo-Generators

FOR SMALL LIGHTING PLANTS

The Kerr Turbine is peculiarly suited to generator driving and our sets are made in suitable sizes to fill all requirements up to 500 kw. alternating and 350 kw. direct current. The operation is economical throughout a wide range of initial steam pressures, the steam economy is improved by superheat, and any exhaust conditions are permissible. When operating non-condensing, the steam consumption compares favorably with that of a high speed engine of the same capacity, while in condensing plants the economy at full loads equals that of the best compound engine and at fractional loads is much better.

A Kerr Turbo-Generator for lighting or small power or both is extremely profitable in any plant having power boilers, since the freedom of the turbine exhaust from oil makes reuse of the exhaust inexpensive and safe for boiler feeding or any other purpose where clean low pressure steam is desirable. See Bulletin No. 22.



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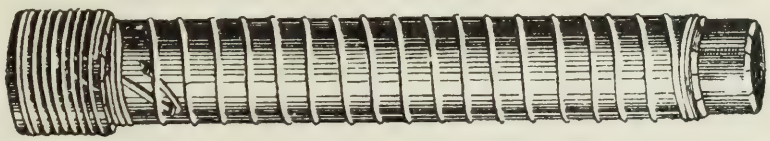
THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO. LIMITED

WOODEN WATER PIPE



Galvanized Wire Machine Banded Wood Stave Pipe

Continuous Stave Pipe

RESERVOIR TANKS

For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

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PACIFIC COAST PIPE CO. LIMITED

Factory: 1551 Granville Street, VANCOUVER, B.C.

P.O. Box 563. Full Particulars and Estimates Furnished.

Edson, Alta.—The Portland Cement Company have prepared plans for an industrial plant at Marlboro, 17 miles west of Edson, on the Grand Trunk Pacific, which will cover nine acres of ground.

Hull, Que.—The Hull Electric Railway Company are building new car shops. They will cost about $25,000.

Fort William, Ont.—Messrs. Park Blackwell, The Matthews Packing Company and the Laing Company will erect an $80,000 cold storage plant at this point.

Fredericton, N.B.—M. M. Haines of Cardigan, N.B. contemplates the erection of a sawmill at the mouth of the Nashwaaksis stream.

Fredericton, N.B.—The management of the John Palmer Company intend to erect a new factory. Chas. R. Palmer, president and general manager.

Lethbridge, Alta.—Among several building contracts recently let are a $40,000 structure known as the Hick-Sehl Block; Geo. Beaton, builder. The Sherlock building, cost $45,000; Smith Bros., contractors. Rukham Block, cost $40,000. Power plant extension, $33,500.

Moose Jaw Sask.—The Western Maufacturing Company intend to erect a modern wood working factory. Mr. T. H. Wilson is general manager of this company.

Naden Harbor, B.C.—Messrs. Wallace Bros., fisheries, are erecting a cannery at this point. J. E. Gilmore, of Prince Rupert, B.C., is contractor.

Ottawa, Ont.—It is reported that Messrs. W. W. & J. Wylie are interested in a $75,000 garage, to be of concrete consruction. It will be of three storeys, and so built that more storeys can be added at will. On the ground floor there will be accommodation for about 100 machines, and the two upper floors will be given up to repair shops and show rooms.

Pincher Creek, Alta.—The municipal council will erect a $15,000.00 town hall. Mr. McDonald architect, of Calagry has prepared the plans.

Port Arthur, Ont.—The Fitzimmons Fruit Co., will erect a new office and warehouse 50 feet by 80 feet, brick and mill construction at a cost of about $25,000.

Stratford, Ont.—The Traders Bank intend to remodel the Scott block for banking purposes. Mr. R. H. Smart is the local manager.

St. John, N.B.—Messrs. N. C. Scott and H. W. Johnston have decided to erect a piano factory near this city.

Toronto, Ont.—C. E. Proctor has obtained a permit for a $40,000 two-storey, brick apartment house at 31-33 Melbourne Avenue. Messrs. Weismuller and MacKenzie Bros. have been granted a permit for a three-storey apartment house on West Queen Street, to cost $75,000. W. R. Phillips & Co. have been granted a permit for a $20,000 warehouse, three-storeys and basement, at the north-west corner of Richmond and Duncan Streets.

Vancouver, B. C.—Work will shortly be started on the erection of a two-storey building which has been designed as an arcade. It will cost approximately $60,000.00. Mr. M. P. Thompson is interested.

Vancouver, B.C.—The North West Canadian Trust Company will proceed with the erection of an eight storey block at 507 Richard Street. The building will be of reinforced concrete construction and will cost $120,000. A six storey reinforced concrete building will be erected for Mr. F. W. Padmore, at 610 Cordova Street, at a cost of $50,000.

BRIDGES, ROADS AND PAVEMENTS.

Welland, Ont.—Tenders will soon be called for new pavement here. Plans and specifications will be on file at the office of The Canadian Engineer, 62 Church Street, Toronto, about March 3rd. D. T. Black, town engineer.

CURRENT NEWS.

Province of Alberta.—Two million dollars will be spent this year by the provincial government on telephone construction in Alberta. The programme includes the construction of over 3,000 miles of rural lines, 500 miles of long-distance lines over new routes, connecting towns along recently-constructed railways, and about 700 miles additional circuits on existing long-distance routes, also a number of new town exchanges as well as extensive additions to existing exchanges. Hon. A. L. Sifton, Provincial Minister of Railways and Telephones.

Calgary, Alta. — The convention of the Builders Exchange will meet in this city in 1913. Ald. Brockelbank has made the arrangements.

Montreal, P.Q.—Messrs. Lyall & Sons have reorganized their company, taking the name of P. Lyall Construction Company, Ltd., with a capital of $4,300,000.

Regina, Sask.—The Educational Committee will recommend to the council that an architect be retained for one year at a fixed salary. This committee contemplate erecting two or more new school buildings.

Saskatoon, Sask.—Twenty firms have tendered to supply the various electrical equipment required by the municipality. The cost of these will be $50,000.

St. Catharines, Ont.—The municipal educational committee intend to spend $400 on the equipment of a physical laboratory for the Collegiate Institute.

Sydney, C.B., N.S.—The new nail mill under construction at the steel plant was somewhat damaged, as the result of a collapse of a portion of it, from a heavy weight of snow on the roof.

Toronto, Ont.—The municipal board of works have made application for the sum of $2,721,000, to carry out their proposed programme of 1912.

Winnipeg, Man.—The Manitoba Government Telephone Commission have purchased a motor truck with a loading capacity of four tons. It is fitted with a special winch, at the rear end of the platform, by means of which a load can be hoisted either to or from the truck, or the winch can be utilized for pulling cable through mains, or in jobs that necessitate power.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ended February 12th, 1912. Fuller information may be obtained by communicating with the Department of Trade and Commerce, Ottawa.

A Birmingham firm of general silversmiths and manufacturers of electro plate wish to appoint agents in every province of Canada.

A London firm of filter manufacturers desire to appoint an agent in every province of Canada. Enquiry is made for the names of Canadian manufacturers of leather cloth.

A Glasgow firm of consulting, inspecting and contracting engineers desire to get into touch with Canadian importers of machinery requiring such services as they can render.

A London firm for filter manufacturers desire to appoint supplies of all kinds desire to do business in Canada.

A West of England firm make enquiry for the names of Canadian manufacturers of wood turnings, such as dowels, spindles, legs for chair work and wooden wheels for toys.

A Birmingham firm of mechanical and electrical engineers manufacturing steam, air, and electrically-driven hauling and winding gears and three throw pumps, electric capstans, etc., wish to be placed in communication with Canadian importers.

A London firm of manufacturing electrical engineers desire to appoint an agent at Vancouver.,

A London firm of mechanical engineers manufacturing air compressors, vacuum pumps, lifting tackle, runways, power transmission, etc., desire to arrange for the sale of their machinery in Canada.

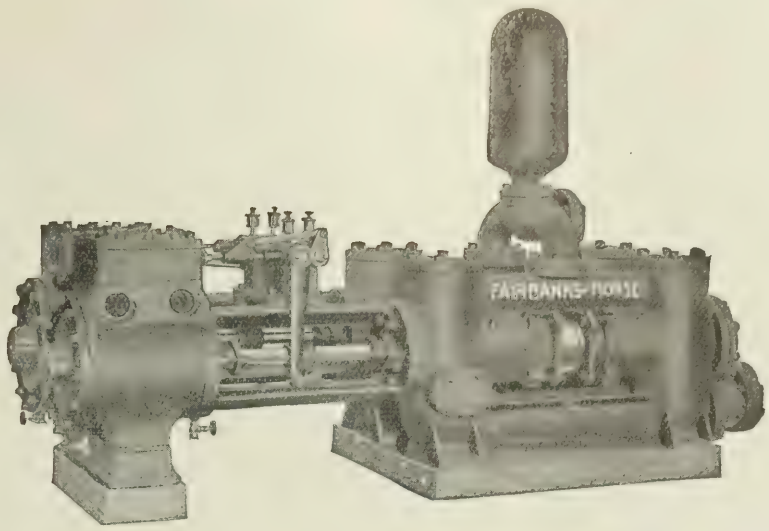
Enquiry is made on behalf of a number of important newspaper publishers in Italy for the names of Canadian manufacturers of news paper.

A London engineer who is proceeding to Canada in April next wishes to obtain agencies for electrical apparatus of every description, electric cranes and other heavy engineering specialties, also hardware lines.

From the branch for City Trade Enquiries, 73 Basinghall Street, E.C.:—

A firm in Southern India wish to get into touch with Canadian importers of tanned sheep and goat skins, and also of tanned cow, calf and buffalo hides.

A London company manufacturing a lamp for exterior and interior lighting, burning methylated spirit, wish to arrange for its sale in Canada.



PUMPS

The superior excellence and splendid results shown by

"FAIRBANKS-MORSE"

pumping machinery are largely due to the fact that for many years we have manufactured Hydraulic Machinery of all descriptions. We are therefore able to build pumps which are properly designed and adapted to every-day use. This is of the greatest importance in a first-class pump, for the usefulness of an engine may be lost if the pumping machine is badly designed.

You will get all these important features when you purchase a "FAIRBANKS-MORSE" pump.

Let us solve your pump problems.

THE CANADIAN FAIRBANKS-MORSE CO. Limited

Fairbanks Standard Scales — Fairbanks-Morse Gas Engines.
Safes and Vaults.

Montreal **Toronto** **Winnipeg** Vancouver Calgary St. John, N.B. Saskatoon Ottawa

PATENTS.

Below will be found a list of patents recently granted to inventors in Canada. This list is furnished by Messrs. Fetherstonhaugh & Company, Royal Bank Building, Toronto: C. A. R. Roy, file protectors; J. W. Mowbray, hydrocarbon vaporizers for internal combustion engines; S. Aikins, door knobs; J. Andron and G. F. Hickmott, ash sifters; R. L. Gardner and S. S. Holden, portable stable tents; S. Ashdown, hooks; W. P. Cahoe, methods of producing a glucose like product from cellulose and ligneous materials; A. G. Hunter, Churns; J. W. Lucas, lantern handles; A. J. McDonald, barrels; T. A. Murray, sewage sedimentation tanks; J. A. Ray, stove lids; J. Samuels, cinder sifters; F. G. Hunt, disc harrows.

The following is a list of Canadian patents recently issued through the agency of Messrs. Ridout & Maybee, Manning Chambers, Toronto: I. S., I. & S. McDougall, insectides and the like; E. D. Gouk, veneer box; C. B. Redrup, Fluid pressure engines or pumps; J. B.Beadman and H. J. Macklin, axle boxes and other bearings; I. H. Storey, flying machine; F. M. Field and D. A. Skene, railway control system; F. Orbell, elevating mechanism; A. H. Reid, concrete; A. W. Cooper and S. H. Watts, cultivator shares; A. C. Thompson, filling spring for mattresses.

H. J. Daniels, potato harvester; Weedon Grossmith, collar for personal wear; Kilgour Bros., paper drinking cup; R. W. Bateman and L. H. Bateman, driving and reversing gear; Bain Wagon Company, Limited, wagon.

The following list of Canadian patents is supplied by Messrs. Fethersonhaugh & Co., 10 King St. E., Toronto:—

C. E. O. Langlois, self couplers for fluid train lines; W. P. Stephenson, display boxes; A. E. McKenzie, seed show cases; M. Filion and H. L. Dumouchel, automatic cattle guards for railroads; W. Topp and F. Topp, automatic fire alarms; L. E. Beaulieu, fish plate bolts; T. H. Elliott, fire escapes; A. Hackett, combined throttle and reversing valves for motors; A. Horwitz, gas water heaters; J. J. Noon, pipe couplers.

MACHINERY FOR RUSSIA.

Mr. A. L. G. Taylor, 629 Corydon Ave., Winnipeg, Man., has asked us to put him in touch with firms in Canada who are prepared to tender for the supplying of the following equipment for works in Russia:—

(a) Electric furnace for scrap iron, 16-25 tons per diem.

(b) A rolling mill of smallest possible size (round) up to 3-inch diameter. (b) Rectangular 1⅞-inch by 1¼-inch and 1½-inch by 1⅝-inch.

(c) Bending and electric welding machines for chains from ⅛-inch to ½-inch.

(d) Stamp and forging machines for scythes, sickles and horse shoes.

(e) Lamps for giving about 200 candle-power from crude naphtha.

(f) Machine lathes for turning pick and axe handles (taper).

(g) Machines for making long boots of thick felt and similar materials.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

15947—February 12—General Order re Rules and Regulations for Inspection of Locomotive Boilers, etc.

15948—February 5—Approving location of G.T.P. Ry. station site at Stony Plains, Alta.

15949—February 12—Authorizing Geo. H. Shaw, G.T.M., N.St. C. & T. Ry. to prepare and issue tariffs of tolls.

15950—February 8—Directing C.P.R. to, before July 1, 1912, install electric bells at crossing in village of Coldwater, Ont., 20 per cent. from Railway Grade Crossing Fund.

15951—February 12—Authorizing C.N.O. Ry. to cross Ford St., Toronto, by overhead structure over highway and across tracks of Toronto Suburban Ry. Co.

15952—February 12—Authorizing C.N.O. Ry. to cross seven highways in Twp. of Etobicoke.

15953—February 12—Directing Bell Tel. Co. to amend Supp. No. 42, C.R.C. No. 1708 and providing for certain changes in rates to telephone subscribers between Island and city of Toronto. (See Order 12625, December 14, 1910.)

15954—February 9—Authorizing C.P.R. (G.B. & S. Ry.) to cross St. Patrick and Dermot Sts. at mileage 72.21 and to take certain lands for road diversion belonging to W. B. Fee, Twp. of Ops, County of Victoria, Ont.

15955—February 6—Approving location of C.N.O. Ry. station at Brockville Junction.

15956—February 12—Directing Grand Valley Ry. Co. to pay to T.H. & B. Ry. $200 for old diamond at crossing on South Market St., Brantford, Ont.

15957—February 9—Authorizing C.P.R. to cross with second main line track (double track) McTavish St., Fort William, Ont.

15958—February 9—Authorizing C.N.O. Ry. to connect with G.T.R. at Cobourg, Ont.

15959—February 9—Authorizing C.N.O. Ry. to cross Russell Road, at Junction Gore, County of Carleton, Ont.

15960—February 14—Directing that crossing of G.T.R. near Kettle Creek Bridge, St. Thomas, Ont., be protected by day and night watchmen, 15 per cent. to be paid by Twp. of Yarmouth, 15 per cent. by city of St. Thomas.

15961—February 15—General Order re freight rates in Canada, west of Port Arthur, adding Province of British Columbia to enquiry.

15962—February 15—Directing G.T.R. to install within ninety days electric bell at crossing of Grand Ile Ave., Valleyfiield, Que.

15963-64—February 14—Issuing certificate of correction to G.T.P.B.L. Co. correcting errors in plan of location Biggar-Calgary Branch and Biggar-Calgary Branch.

15965—February 12—Relieving C.P.R. from erecting and maintaining fences, gates and cattle guards on portions of Atlantic, Eastern, Ontario and Lake Superior Divisions.

15966—February 15—Authorizing C.P.R. (G.B. & S. Ry.) to use and operate bridges at mileages 20.64, 23.4 and 24.3 at Couchiching Narrows.

15967—February 3—Authorizing C.P.R. to construct spur for A. Bowerman in city of Saskatoon, Sask.

15968—January 31—Authorizing C.N.R. to cross with its Grosse Isle Branch twelve highways in municipality of Woodlands, Man.

15969—February 13—Amending Order No. 15667, December 15, 1911, by substituting plan "B" for plan "A" filed.

15970—February 15—Extending until July 1, 1912, time for construction of spur by C.N.R. in city of Edmonton, in H. B. Reserve.

15971—February 15—Approving coal chute clearances of G.T.P. Ry.

15972—February 14—Authorizing Edmonton, Dunvegan & B.C. Ry. Co. to cross highways from mileage 0 to 30, Alberta.

15973—February 15—Adding Twp. of Bentinch to application re protection of crossing by Walkerton & Lucknow Ry. (C.P.R.), County Grey, Ont.

15974—February 14—Approving plan "A" and rescinding Order 14066 of June 24, 1911, in so far as it approves the plans of said automatic signal on T.H. & B. Ry. between Hamilton and Vinemount.

15975—February 15—Certificate of correction to G.T.P.B.L. Co. re errors in plan of location of Biggar-Calgary Branch.

15976—February 16—Re Brockville train connection between G.T.R. and C.P.R. when passengers for Ottawa on G.T.R. train.

15977—February 15—Approving location of C.N.O. Ry. station grounds at St. Joseph, Parish of St. Eustache, County Two Mountains, Que.

15978—February 14—Authorizing C.N.O. Ry. to cross C.P.R. by overhead structure on Lot 11, Con. 2, Twp. of Nepean, County of Carleton, Ont.

15979—February 16—Certificate of correction to G.T.P.B.L. Co. correcting errors in location Biggar-Calgary Branch.

15980—February 15—Authorizing C.N.R. to construct spur to Round Hill Collieries, Ltd., Province of Alberta.

15981—February 16—Approving by-law of T.H. & B. Ry. authorizing F. D. Backus, G.F.A. and P.A., and Geo. C. Martin, A.G.F. and P.A., to prepare and issue tariffs of tolls.

15982—February 14—Authorizing Twp. of York to construct bridge over old belt line, so-called, of G.T.R. east of Yonge St., and to open up a new highway.

15983—February 15—Authorizing G.T.P. Ry. Co. to operate industrial spur to serve P. Burns & Co., Ltd., Edmonton, Alta.

15984-85—February 16—Approving revised location of C.P.R. Virden to McAuley Branch from mileage 14 to mileage 36.27, Manitoba and Saskatchewan, and revised location of Kerrobert Northeasterly Branch from mileage 0 to mileage 20.2, Saskatchewan.

15986—February 16—Authorizing C.N.O. Ry. to cross three highways in Twp. of Nepean, County of Carleton, Ont.

15987—February 16—Rescinding Order No. 14379, July 22, 1911, and authorizing C.P.R. to divert public road between Cons. 7 and 8, Twp. of Eldon, County of Victoria, and to cross diversion at mileage 56.4 by overhead bridge, company to also compensate John McArthur by reason of any damages sustained by closing highway.

15988—February 17—General Order re Ash Pans on Locomotives.

15989—February 16—Authorizing G.T.P. Ry. to cross with its second track of C.N.R. on Empire Ave., Fort William, Ont.

15990—February 15—Authorizing C.P.R. to construct spur for Manitoba Bridge & Iron Works, Ltd., on Higgins Ave., Winnipeg, Man.

15991—February 16—Approving revised location of James Bay & Eastern (C.N.R.) through Twp. of Demeules, County of Lake St. John, Que.

15992—February 16—Directing C.N.R. under penalty of $10 per day to, before May 15, 1912, provide suitable farm crossing for E. K. Glidden, of Vermilion, Alta.

15993—February 15—Dismissing application of Dominion Sugar Co., Ltd., Wallaceburg, Ont., re re-adjustment of rates on sugar in carloads from Wallaceburg to Winnipeg and western points.

(Continued on Page 74.)

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The Canadian Engineer

An Engineering Weekly

RAILLESS TROLLEY CARS.

The railless trolley system which of late has undergone severe development, forms a link in modes of transportation between the automobile and the familiar central power driven street car, in use throughout many cities and districts on the North American continent.

The railless system of street transportation has many advantages over the pre-existing type, among which might be mentioned the disposal of track expenses and the diminished possibility of a block on the right of way.

The many municipalities throughout Great Britain have probably done more to encourage the development of this system of transportation than any foreign communities. In fact, the municipalities of Leeds and Bradford lay claim to being the possessors of the first commercial railless lines in the United Kingdom. A description of these lines has been given by the "Tramway and Railway World," and with their permission we publish the photographs accompanying this article.

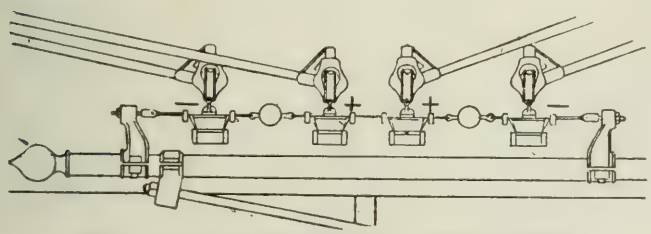

Fig. 1.—Bracket Supports for Overhead Wires.

The corporation of Leeds a few years ago gave serious attention to this system of transportation, owing to a district situate to the southwest of the municipality which was in need of transportation facilities, but too sparsely populated to make a regular tramway system remunerative. A thorough investigation of railless trolleys was made by the Tramways Committee and a report was made. The investigation included a visit to Austria, Northern Italy and Germany.

Shortly after the issuing of the report the corporation applied for powers in the session of 1909-10 to equip the route for railless traction.

A consideration of this system will show that the main points of departure from the ordinary tramway system are the tires, the methods of trolley contact, and the method of trolley wire support.

The poles of the Leeds Tramways are 8 in. diameter at the base, with a top diameter of 6 inches, and 7 inches at base, with a top diameter of 5 inches; the weight of these are 1,213 pounds and 890 pounds each.

The overhead wires (+ and —) are of 0000 S.W.G. grooved, hard drawn, copper. Fig. 1 shows the method of wire support from the bracket; the two outer ones being negative and the central ones positive.

The bracket arm supporting these extends 18 feet from the pole. This method of construction gives double insulation between the two positives and treble insulation between the bracket arm and the negative.

This system is arranged in such a manner as will allow the extension of the existing track tramway system, should pecuniary circumstances call for such; the current is supplied to the feeders from the pre-existing power station, the pressure being 525 volts, direct current.

Section boxes and section insulators divide the positive wires into half-mile sections as in standard tramway practice, but the negative wires are continuous from end to end of

Fig. 2.—Railless Trolley.

the route, and cross connected at intervals of half a mile to minimize losses, and for the same reason the negative wires are bonded to the existing tramway rails near the terminus.

The method of completing the circuit between the trolley and motors is illustrated in Fig. 2. This, of course, is the critical feature of the system.

The trolley is of the under-running type, capable of allowing the vehicle to run at a distance of 15 ft. from the centre of the wires, measuring from the centre of the vehicle. It is so arranged that the negative trolley may be put out of action, and thus allow the vehicle to run with the positive trolley only on the line.

A rail collector has been included in the fittings of the car. This is used when the vehicle is taken in or out of the central depot and where no overhead negative wires are provided. It consists of a skate hinged at the rear end of the vehicle, and is provided with means for raising and lowering, so that when the negative trolley is out of action the electrical circuit may be completed through the ordinary tramway rails, and thus allow the car to proceed along any existing tramway route. The arrangement allows a maximum deviation of five feet.

The cars are of similar construction to the ordinary tramway type in many particulars, as may be gathered from an examination of Fig. 3. The general mechanical make-up is clearly shown in Fig. 4 and Fig. 5. It will be seen that two motors supply motivity to the rear wheels. The motion is transported by means of double reduction worm-wheel and chain gearing, the former working in an oil bath. Each chain is of the roller type, protected by a case giving easy access to chain and wheel, and the latter is case hardened. The power cables are run in screwed conduit tubing filled in with bitumen.

The wheels are fitted with solid rubber tires, the rear wheels supporting two each.

Two mechanical brakes are provided, one being connected to the counter shaft and operated by a foot pedal, and the other consisting of drum brakes on the rear wheels, operated by either foot pedal or hand lever, with ratchet device for retaining the brake in the one position.

The motors have a capacity of 20 b.h.p. at 525 volts, and a speed of 1,050 revolutions per minute, equivalent to a speed of 10 miles per hour. They are of the Siemens type, series wound with shunted fields, provided with commutating poles, and having wool waste oil lubrication. The controller is of the Siemens series-parallel magnetic blow-out type, provided with special arrangements for cutting out either motor as desired, but having no provision for rheostatic braking. The main barrel has nine positions in addition to the off position, and the reversing barrel six.

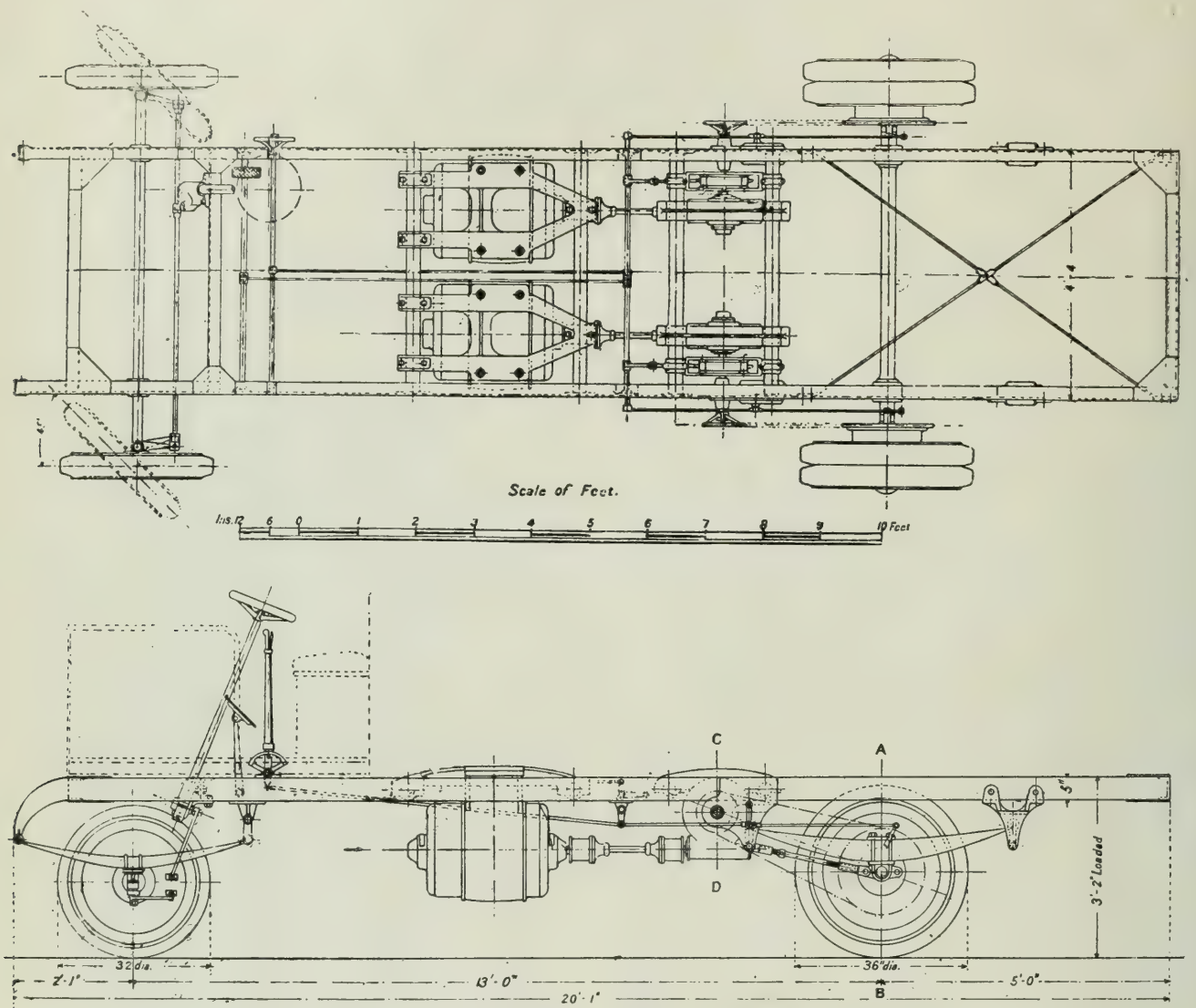

Fig. 4.—Plan and Side Elevation of Chassis of Railless Trolley Car.

GRAND TRUNK IN THE UNITED STATES.

Tenders have been requested by the Grand Trunk Railway Company for the construction of roadbed and buildings of the Southern New England railway, which will bring the Grand Trunk Company from Palmore, Mass., to Tidewater in the city of Halifax, N.S. The contracts call for completion of everything in connection with extension of the road on or before December 31st, 1913. The company officials expect to have trains running over the new road before the end of this year.

SPECIFICATIONS FOR THE ERECTION OF RAILROAD BRIDGES.

The following specifications for bridge erection were submitted by the Committee on Iron and Steel Structures to the American Railway Engineering Association, and will be considered at the annual meeting of the association. The committee recommend that they be adopted and printed in the manual.

1. Work to Be Done.—The contractor shall erect, rivet and adjust all metal work in place complete, and perform all other work hereinafter specified.

2. Plant.—The contractor shall provide all tools, machinery and appliances necessary for the expeditious handling of the work, including drift pins and fitting up bolts.

3. Falsework.—The method of erection and plans for falsework and erection equipment shall be subject to approval by the engineer, but such approval shall not relieve the contractor from any responsibility. Falsework will be built by *..... Falsework material of every character will be provided by the *.....

The temporary structure for use during erection and for maintaining the traffic shall be properly designed and substantially constructed for the loads which will come upon it. All bents shall be thoroughly secured against movement, both transversely and longitudinally. The bents shall be well secured against settling, and piles used wherever firm bottom cannot be obtained. Upon completion of the erection, the temporary structure, if the property of the railway company, shall be removed without unnecessary damage, and neatly piled near the site or loaded on cars, as may be directed. If the property of the contractor, it shall be removed in a manner subject to the approval of the engineer.

Falsework placed by the railway company under an old structure or for carrying traffic, may be used as far as practicable by the contractor during erection, but it shall not be unnecessarily cut or wasted.

4. Conduct of Work.—The work shall be prosecuted with sufficient force, plant and equipment to expedite its completion to the utmost extent and in such a manner as to be at all times subordinate to the use of the tracks by the railway company, and so as not to interfere with the work of other contractors or to close or obstruct any thoroughfare by land or water, except under proper authority.

Reasonable reduction of speed will be allowed upon request of the contractor.

Tracks shall not be cut nor shall trains be subjected to any stoppage except when specifically authorized by the engineer.

The contractor shall protect traffic and his work by flagman furnished by and at the expense of the railway company.

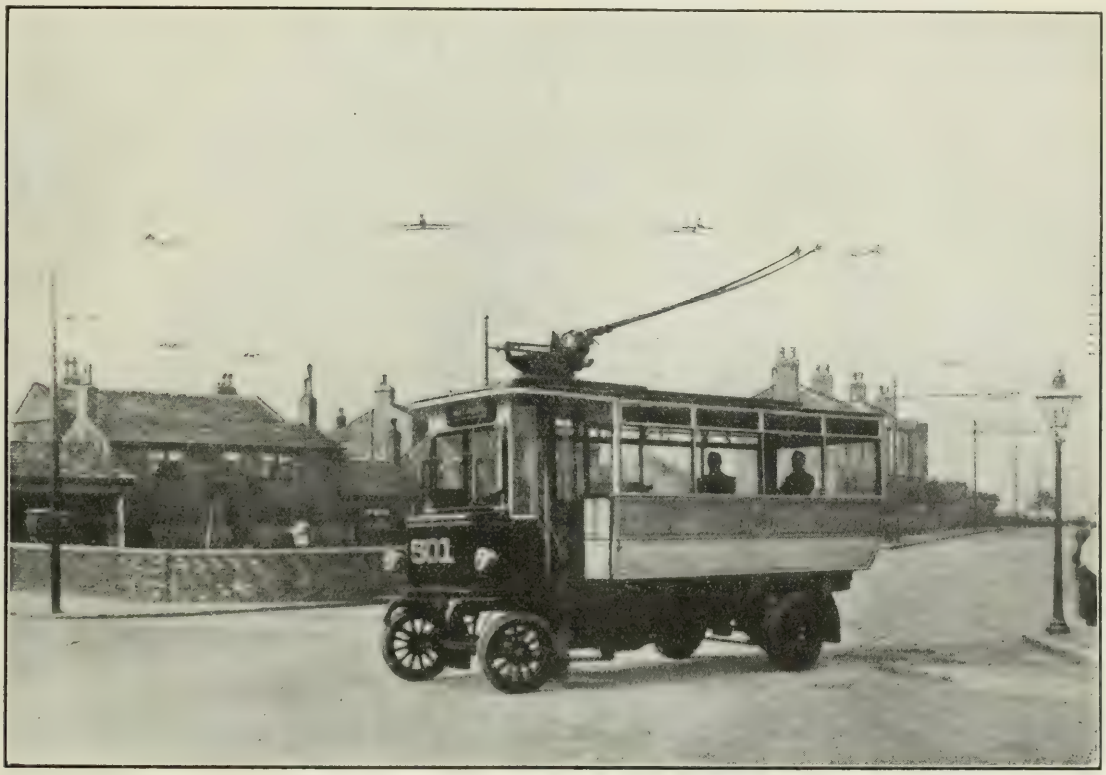

Fig. 3.—Railless Car Rounding Loop.

The contractor shall provide competent watchmen to guard the work and material against injury.

5. Engine Service.—If under the contract, work train or engine service is furnished the contractor free of charge, such service shall consist only in unloading materials and in transferring the same from a convenient siding to the bridge site. Other engine service shall be paid for by the contractor at the rate of $..... per day per engine, the time to include the time necessary for the engine to come from and return to its terminal. When engine service is desired the contractor shall give the proper railway officials at least 24 hours' advance notice and the railway company will furnish the service as prompty as possible, consistent with railroad operations.

When derrick cars are used on main tracks, their movements shall be in charge of a train crew, and the expense of the crew and any engine service other than as noted above shall be charged to the contractor.

* Insert "railway company" or "contractor," as the case may be.

6. Transportation.—When transportation of equipment, materials and men is furnished free over the railway company's line, it shall be subject to such conditions as may be stated in the contract.

7. Masonry.—The railway company will furnish all masonry to correct lines and elevations, and unless otherwise stated in the contract, will make all changes in old masonry without unnecessarily impeding the operations of the contractor. The railway company-s engineers will establish lines and elevations and assume responsibility therefor, but the contractor shall compare the elevations, distances, etc., shown on plans, with the masonry as actually constructed as far as practicable, before he assembles the steel. In case of discrepancy, he shall immediately notify the engineer.

8. Handling and Storing Materials.—Cars containing materials or plant shall be promptly unloaded upon delivery therefor, and in case of failure to do so the contractor shall be liable for demurrage charges. Material shall be placed on skids above the ground, laid so as not to hold water, and stored and handled in such a manner as not to be injured or to interfere with railroad operations. The expense of repairing or replacing material damaged by rough handling shall be charged to the contractor. The contractor, while unloading and storing material, shall compare each piece with the shipping list and promptly report any shortage or injury discovered.

9. Maintenance of Traffic.—When traffic is to be maintained it will be carried on in such a manner as to interfere as little as practicable with the work of the contractor.

Changes in the supporting structure or tracks required during erection shall be at all times under the direct control and supervision of the railway company.

10. Removal of Old Structure.—Unless otherwise specified, metal work in the old structure shall be dismantled without unnecessary damage and loaded on cars or neatly piled at a site immediately adjacent to the tracks, and at a convenient grade for future handling, as may be directed. When the structure is to be used elsewhere all parts will be matchmarked by the railway company; when the old bridge is composed of several spans the parts of each shall be kept separate.

11. Metal Work.—Material shall be handled without damage. Threads of all pins shall be protected by pilot and driving nuts while being driven in place.

Light drifting will be permitted in order to draw the parts together, but drifting for the purpose of matching unfair holes will not be permitted. Unfair holes shall be reamed or drilled.

Nuts on pins and on bolts remaining in the structure shall be effectively locked by checking the threads.

All splices and field connections shall be securely bolted prior to riveting. When the parts are required to carry traffic, important connections, such as attachments of stringers and floor beams, shall have at least fifty (50) per cent. of the holes filled with bolts and twenty-five (25) per cent. with drift pins. All tension splices shall be riveted up complete before blocking is removed. When not carrying traffic, at least thirty-three and one-third (33⅓) per cent. of the holes shall have bolts.

Rivets in splices of compression members shall not be driven until the members shall have been subjected to full dead load stresses. Rivets shall be driven tight. No recupping or calking will be permitted. The heads shall be full and uniform in size and free from fins, concentric and in full contact with the metal. Heads shall be painted immediately after acceptance.

Rivets shall be uniformly and thoroughly heated and no burnt rivets shall be driven. All defective rivets shall be promptly cut out and redriven. In removing rivets the surrounding metal shall not be injured; if necessary, the rivets shall be drilled out.

12. Misfits.—Correction of minor misfits and a reasonable amount of reaming shall be considered as a legitimate part of the erection.

Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins, and a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to the engineer and the work of correction done in the presence of the engineer, who shall check the time expended.

The contractor shall render an itemized bill for such work of correction for the approval of the engineer.

13. Anchor Bolts.—Holes for all anchor bolts, except where bolts are built up with the masonry, shall be drilled by the contractor after the metal is in place and the bolts shall be set in Portland cement grout.

14. Bed Plates.—Bed plates resting on masonry shall be set level and have a full even bearing over their entire surface; this shall be attained by either the use of Portland cement grout or mortar, or by tightly ramming in rust cement under the bed plates after blocking them accurately in position.

15. Decks.—The *..... will frame and place the permanent timber deck.

16. Painting.—The waint will be furnished by *..... ..... and shall be of such color, quality and manufacture as may be specified.

Surfaces inaccessible after erection, such as bottoms of base plates, tops of stringers, etc., shall receive two coats of paint before assembling in place. After erection, the entire structure shall receive two coats of paint, allowing enough time between coats for the first coat to dry before applying the second. No paint shall be applied in wet or freezing weather, nor when the surface of the metal is damp. Painting shall be done in good and workmanlike manner, subject to strict inspection during progress and after completion, and in accordance with special instructions which shall be given by the engineer. All metal shall be thoroughly cleaned of dirt, rust, loose scale, etc., before the the paint is applied.

17. Clearing the Site.—The contractor, after completion of the work of erection, shall remove all old material and debris resulting from his operations and place the premises in a neat condition.

18. Superintendence and Workmen.—During the entire progress of the work the contractor shall have a competent superintendent in personal charge and shall employ only skilled and competent workmen. Instructions given by the engineer to the superintendent shall be carried out the same as if give to the contractor. If any of the contractor's employees by unseemingly or boisterous conduct, or by incompetency or dishonesty, show unfitness for employment on the shall, upon instructions from the engineer, be discharged from the work, nor thereafter be employed upon it without the Engineer's consent.

19. Inspection.—The work of erection shall at all times be subject to the inspection and acceptance of the engineer.

20. Responsibility.—The contractor shall assume all responsibility for less or damage to his own work, materials or plant, due to any cause; also, for all loss or damage to the railway company's materials or property, and to other property adjacent to the railroad, due to causes within his reasonable control.

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* Insert "railway company" or "contractor," as the case may be.

The contractor shall assume all responsibility for injury to the workmen and the public, or to any individual; and in case of accident or suit he shall defend the suit in person and relieve the railway company from all costs and expenses, and pay any judgments that may be recovered thereon.

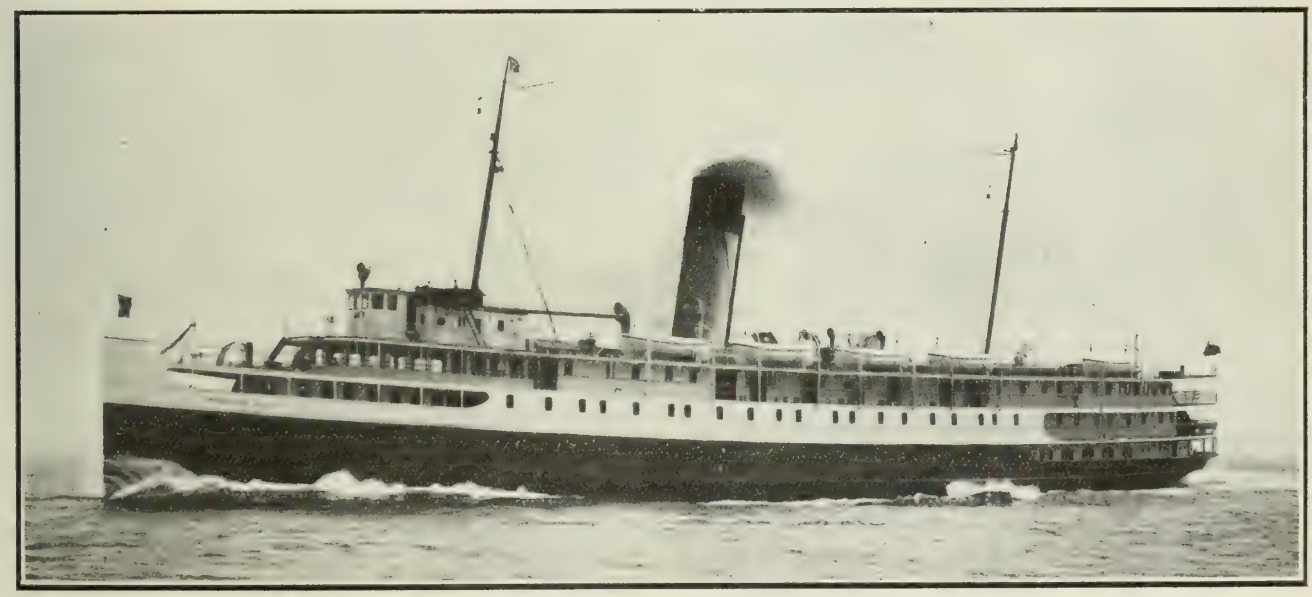
The contractor shall comply lith the laws and ordinances affecting the manner of doing work; shall take out all necessary permits and comply with their requirements, and shall take such precaution as may be necessary to protect life and property.

21. Insurance and Bond.—The contractor shall carry such liability insurance as is necessary to protect himself and the railway company against loss or damage caused by injuries to his men, and shall furnish the railway company a bond in form and of a surety acceptable to the railway company, providing for the faithful performance of the work and all matters pertaining thereto, in such sum as shall be specified in the contract.

22. Engineer.—The term "engineer," as used herein, shall be understood to mean the chief engineer of the railway company, or his accredited representative.

THE TWIN SCREW STEAMSHIP, "PRINCESS ALICE," FOR THE BRITISH COLUMBIA COASTAL SERVICE OF THE CANADIAN PACIFIC RAILWAY CO.

The twin screw steamship, "Princess Alice," illustrated in the photograph, has just recently been introduced into the British Columbia service of the Canadian Pacific Railway Co., and is now in regular operation between Vancouver, Victoria and Seattle. This vessel, which was constructed by Swan, Hunter and Wigham Richardson, Ltd., of Wallsend-on-Tyne, has a length between perpendiculars of 290 ft., a moulded depth from the keel to the main deck at the side of 17 ft., and a beam of 46 ft. 2 in. She was built to the requirements of the Canadian Government for the Pacific Coast and channel service, and carries the highest class of Lloyd's Registry, and takes her passengers and cargo on a draught of 12 ft. 6 in. She is fitted with one set of four-cylinder triple-expansion engines, having one h.p. cylinder 27 in. in diameter, one i.p. cylinder 42 in. in diameter, and two l.p. cylinders, each 48½ in. in diameter, with a common stroke of 39 in. The first h.p. and i.p. cylinders are fitted with piston valves, and the l.p. cylinders are fitted with flat-slide valves having relief valves at the back. The engines are balanced on the Yarrow, Schlic and Tweedy system, and they are fitted with all the latest improvements, which include Brown's reversing engine and special lubricating arrangements suitable for the high speed at which they run. The condenser is of Weir's "Uniflux" type and Weir's "Dual" air pump is fitted, the circulating water being supplied by a centrifugal pump driven by an entirely enclosed engine. There are no pumps of any description worked from the main engines. The main feed pump consists of a pair of Weir's vertical pumps with float control. Duplicate pumps are provided for dealing with the various services of the ship—two for bilge purposes, a vertical ballast pump for fresh water, and a general service pump. An ash ejector is fitted in each stokehold, worked by a special duplex donkey. A Sentinel steam ash hoist is provided for port use. The evaporator and feed heater are of Weir's manufacture, and a feed water filter is also fitted. There are four boilers, 15 ft. 7 in. in diameter, by 12 ft. in length, each fitted with three furnaces and worked under forced draught on the enclosed stokehold system. An interesting feature of this ship is that she is the first of the Canadian Pacific Railway Company's fleet that has been specially built to carry oil fuel for raising steam in the boilers, although, of course, oil-burning apparatus has previously been installed into several of the older steamers of this company. The patented system of the Wallsend Slipway and Engineering Co., Ltd., was adopted and the installation is a very simple one. The oil is pumped from the liquid fuel bunkers through a heater and filter to the burners and is simply sprayed into the furnaces under pressure. The salient feature of this system is the method in which the air is brought into contact with the spray of liquid fuel, this being effected in such a manner as to secure perfect combustion within a very short distance from the mouth of the furnace. The method is so simple that it can be easily worked by an unskilled laborer after half an hour's instruction, as all that is necessary is to merely adjust the temperature and pressure to suit the quantity of oil which is required to be burned to obtain the requisite power. Another feature is the oil-spraying nozzle, which is so arranged that by simply changing the nozzle of



New Liner for Canadian Pacific Railway Co., S.S. "Princess Alice."

the burner and a small disc in the inside of it, the quantity of oil may be varied from a maximum to a minimum. When burning liquid fuel on this system, all brickwork is entirely removed from the furnaces and from the moment of lighting there is no smoke to be seen from the ship's funnel. The Passenger accommodation of the "Princess Alice" embodies all that the experience of the owners and the skill of the builders could devise, and the ship is, therefore, one of the most handsome on the Pacific Coast. As will be gathered from the elevation drawing and the photographs, the "Princess Alice" has a large range of superstructure and is a typical example of the most recent practice in Canadian river and coastal steamers. On the promenade deck the observation room is placed forward and the smokeroom aft, both of these rooms having large plate glass windows, which afford an uninterrupted view of the splendid scenery of the coast along which the ship passes. The observation room is handsomely panelled in mahogany, and the smokeroom in fumed oak, relieved by hammered copper panels, depicting ancient "totem" poles of the North American Indians, and also specimens of the trees, fruits and grain of Canada. The corridors between the observation and smoke rooms are of polished mahogany with inlaid panels, and they lead to a succession of comfortable deckhouse staterooms. A feature of the corridors is that they are all surmounted by a cambered roof with a clerestory, giving a feeling of height and spaciousness and ample light and ventilation. From the promenade deck, companion-ways lead down to the upper deck, which is largely occupied by a series of first-class staterooms, including several suites of bridal chambers. On this deck there are also two social halls, or music-rooms. The dining saloon, a handsome apartment panelled in beautiful Italian walnut, is on the main deck aft, and a noticeable feature of this room is the provision of specially large plate glass windows. The saloon is arranged with small tables, those at the sides being ensconced in bays. At the after end of the dining room is the pantry and behind that a galley. Under the dining-room deck is the first-class restaurant, where a la carte meals are served. The photograph showing the vessel was taken whilst she was undergoing official trials off the Tyne and burning liquid fuel, when a speed of 18 knots was easily attained, and during this time, and whilst the vessel was on her way to Victoria, British Columbia, and also for the short time she has been in commercial service, we understand, the machinery and boilers have worked to the complete satisfaction of all concerned, the owners being represented by Captain H. Mowatt, their marine superintendent. It is of interest to note that the Canadian Pacific Railway Co. has at present 15 vessels engaged in the Atlantic trade with a total gross tonnage of 125,666 tons. The largest of these steamers are the sister ships, "Empress of Britain and "Empress of Ireland," the gross tonnage of each of which being approximately 14,500 tons. The Pacific service is maintained by four steamers, the total gross tonnage of which is 23,984 tons, three of which are the well-known vessels "Empress of China," "Empress of Japan," and "Empress of India." The British Columbia service is now being carried on by nine vessels, the total gross tonnage of which amounts to 19,977 tons. The Canadian Pacific Railway Co., has at present three steamers on the stocks in this country, two large and fast vessels for trans-Pacific service, the gross tonnage of which will be approximately 15,000 tons. The other vessel is intended for the Pacific Coast service, and will have a tonnage of about 2,000 tons for the coast service and the Canadian Pacific Railway has also acquired the 1,000-ton steamer "Queen Alexandra," which is now refitting on the Clyde and will, in due course, take her place in the coast service under the new name "Princess Patricia."

ENGINEERING PHOTOGRAPHY.

By Lyman B. Jackes.

It is seldom nowadays that any structure is completed without the securing of a number of photographs. Many instances may be cited where this faithful servant has placed on record the various epochs and points of interest which are hidden when the problem or structure assumes a finished condition.

In the construction of many large buildings in United States cities, photographs are secured of all surrounding conditions to serve as infallible witnesses, should a process of law be resorted to when building operations have commenced. The writer recently saw a photograph of several persons gazing into the windows of a jewel merchant's shop on Broadway, New York; the scene also depicted one or more persons in the act of leaving and entering the premises. This photograph was secured to assist in defending the contractors engaged in erecting one of the world's largest office buildings against a damage suit entered by the above mentioned merchant, who alleged that the litter, noise and dirt, etc., of the construction work drew custom from his store.

Stripped of all technical terms and accessories, the photographic principle depends on the fact that certain salts of silver are capable of changing properties due to the action of light and that these changes may be developed from the latent condition to one of perceptability. The silver salts are generally supported by means of gelatine on glass, celluloid or paper, the former condition being known as a "plate" and the second a "film."

Photographers are divided largely on the question of which form presents the more points of excellence, but both possess equal latent powers for negative making when properly handled. The prominent advantage claimed for films over plates is that of weight and ease in manipulation; that of plates being cheapness, (usually 50% lower than films) variety, both in make and properties, and stillness; while the disadvantages claimed for films are inflammability and lack of variety. By lack of variety is meant the selection of a certain plate, be it landscape, process, non-filter or ordinary, for a special piece of work.

In making pleasing and presentable pictures the great factor is the lens; in fact without a lens of some sort photography would be greatly handicapped, although it is possible under extreme conditions to secure passing negatives without a lens.

Lenses are divided into two great classes, single and double, these two classes branching off into many subdivisions. The photographic lens, like many other articles, is the result of many men's brains; the chief improvements, however, might include the compounding of two lenses into a "single" one, known as an achromatic; the compounding of two single lenses to correct linear distortion, known as rectilinear; and the compounding of the two former in various ways to correct stigmatism, and known as anastigmatic.

The single lens finds its chief employment in the lower priced cameras, but, unfortunately, has not the power to produce a straight line upon the plate or film. Owing to this defect, it does not commend itself for engineering photography; the rectilinear lens corrects this fault, and has the advantage of passing much more light in a given time. The anastigmatic lens may be regarded as the highest development (for general all round work) of the lens making art. This type lens is much more expensive to purchase than the former mentioned types, but a fair anastigmatic lens of British manufacture may be obtained in this country for

from twelve to fifteen dollars and upwards. Lenses of this character purchased from the United States are, as a rule, much higher priced. A good single lens may be had from one dollar upwards, while the rectilinear variety may be obtained from three dollars upwards.

When a mechanical device or engineering construction has reached the stage where photography is called upon to enter the general scheme it is usual to exclude all idea of the artistic and brush all other features aside in the idea of securing the picture containing the most descriptive material.

Next to the lens and plate, the important item in picture making and taking is the diaphragm or "stop." This is a contrivance which admits of regulating the amount of light passing through the lens and, what is still more important, how much of the lens will be used. In most lenses of to-day the diaphragm is built into the lens cell (called an iris diaphragm) and regulated by a ring or lever which plays across a scale to show the relative size of one opening to another. Each number is placed in such a position as to indicate a reduction of 50% in area over the preceding number when the ring or lever is arranged over it.

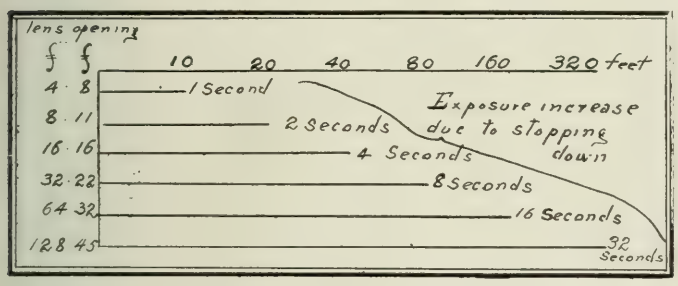


Fig. 1.

In explaining the use of these diaphragms it will be necessary to consult Figure 2. The figures on the top represent the distance in feet from the lens to the first principal object in the foreground. When the lens is open to its greatest photographic ability (represented by the upper left-hand set of figures) it will sharply focus any object at the distance indicated on the scale, but beyond this principal object the definition will become indistinct or "fuzzy." Assuming the operator desires the detail to extend farther into the picture than where the first principal object only appears sharp, this accomplished by stopping down the lens, and not by altering the focus. This might be put as a rule and read: "In focusing always regard the first principal object as the starting point, then consider what depth is required, and arrange this by the stops or diaphragm."

An examination of Figure 2 will disclose the fact that the smaller the opening used the more detail is secured. Allowance, however, must be made for the reduction in the light to secure equal contrast. An example will render this clear.

In Figure 3 assume the camera operator to be considering the taking of two views—one a group of workmen (a) and the other the interior of a power house (b). The group of workmen are drawn up in single line and twenty feet in the rear is a generator that they have been erecting. The purpose of securing this photograph is to photograph the workmen and not the generator, which is to be used as a background. An examination disclosed the fact that the men are fifteen feet from the lens and the generator thirty-five feet distance. If the lens is placed in such a position that the indicator points to fifteen feet, and the lens opened to its greatest capacity, the group will appear sharp and distinct, but beyond the group the detail will be very poor and the generator acting in this instance as a background, will perform its duties by keeping in the background and centering all interest on the group.

In the case of (b) the circumstances differ greatly inasmuch as detail is required. The operator would set his indicator at 25 feet and then arrange his lens opening so that stop f 32 was in the lens; this would evenly distribute the detail; allowance, of course, would be made for the reduction in light passing abilities as illustrated in Fig. 2. The distance from the lens to generator No. 1 is twenty-five feet, and, assuming the total length occupied by machinery to exceed this by one hundred feet, then stop No. 1 (f 8 or f 4) would render generator No. 1 sharp, the next stop would cut fifty feet, the next one hundred and the next two hundred; this includes the hundred and twenty-five feet and should be adapted (4–8–16–32) or the fourth stop. Once the relation between the focusing scale on a hand camera and the stops controlling the opening through the lenses is mastered, the operator has travelled a long portion of the road to successful picture making.

Of great importance is the light available when an exposure is about to be made, as, of course, the length of time in which the shutter remains open is governed entirely by this factor. The brightest portion of the year is obviously during the hours of 10 a.m. and 2 p.m. in the months of June and July; the darkest period is six months later. However, the important factor in estimating available light is not so much in the season's change, but in the hourly change. Under ordinary circumstances 7 a.m. may be regarded as the earliest average time in which successful negatives may be produced; and 4 p.m. may be regarded as the latest average time.

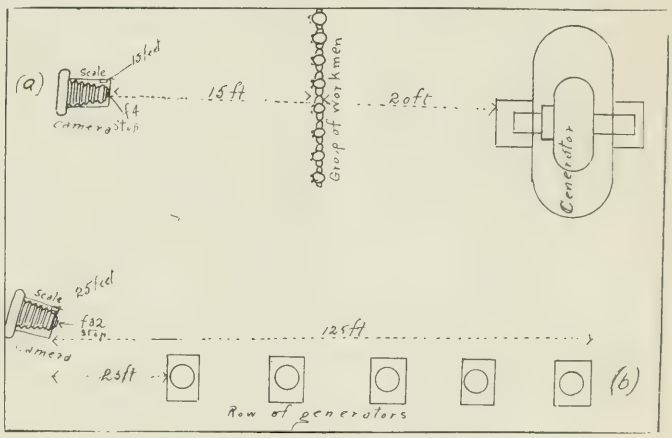


Fig. 2.

Exposure.—Fig. 4 is a curve showing the light value for a year for the district comprising the southern parts of Canada made on a noon comparison. Of course available active light in June will be of greater duration than in December, so that in making an exposure in the afternoon this must be accounted for.

An old photographic maxim is "Expose for the shadows and the high lights will take care of themselves." This is true to a certain extent in general photography, but would not yield results in certain specific cases.

There is generally found on a box of plates a "speed number" which is very useful in making an exposure. This figure is generally given in the H. & D. or Hurter and Driffield system.

The Eastman and Ensign film may be rated on the above system at 275 H.D. This figure represents that the plate or film quoted thus is practically twice as sensitive to light as one rated or quoted at 150, and consequently if the exposure of any specific plate for a given subject is known it becomes

merely a matter of division or multiplication to calculate the exposure for any given subject.

It is a very difficult matter to lay down any hard and fast table for exposures, but the following is from the writer's experience, based on a plate of a speed varying from 200–300 H.D. (average of 250) in a good light:

Subject.	Stop.	Time.
Distant landscape	8–11	1/100 second.
Rivers, snow scenes	8–11	1/100 second.
Light foreground	8–11	1/25 second.
Heavy foreground	8–11	1/5 second.
Portraits near windows	8–11	4 seconds.
Shady banks, brooks	8–11	1/5–1/2 second.
Ravines and under trees	8–11	1/4–1 second.
Interiors, light	8–11	5 seconds.
Interiors, medium	8–11	60 seconds.
Interiors, dark	8–11	30 minutes.
Interiors, very dark	8–11	60/100 minutes.

In photographing interiors with plates a decided improvement will be found by using "backed" plates, which may be purchased from most dealers at a slight advance in price over the unbacked. Failing to procure the article in this form, the dealer will generally suggest to apply the application of a backing preparation contained in a small jar or pot. The glass side of the plate may be coated with:

Strong gum solution	1 oz.
Caromel	1 oz.
Burnt sienna (powder)	1 oz.

This is applied in the dark room and the plates dried in a dark box. It is a good plan to use the plate box by securing small blocks of wood to the side; or they may be stood on a drying rack and then enclosed and protected from the light during the drying period.

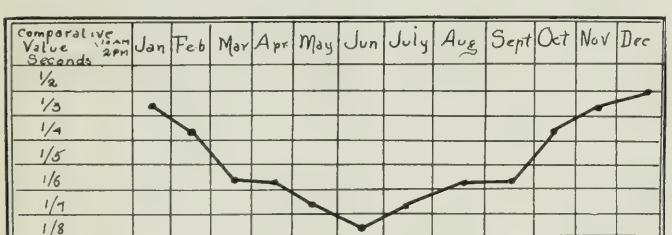


Fig. 3.

Orthochromatic Photography.—The average photographer is usually not long in discovering that his pictures do do not reproduce in the corresponding shades of brilliancy as compared with the colors of the object. This is due to the varying actinic powers of the various light rays, which is more prominent in the blue and violet light than in the yellow and reds. If an exposure is made of any brilliant colored object the resulting negative will be denser in the blue portions and thinner in the red portions than the actual color comparison appeared in nature. To remedy this an orthochromatic plate was introduced, which consisted of an ordinary plate immersed in a solution of certain analine dyes which left a slight yellowish stain on the film, and to a certain extent held back the blue and violet rays while the red, yellow and brown rays were affecting the silver solution. The color correcting properties of an orthochromatic plate are a distinct advance over an "ordinary" plate, but the full correcting properties are only brought out when a yellow screen is placed over the lens either on the front or rear combinations. These yellow screens are usually sold with a factor generally expressed as 2x, 4x, 6x or 8x, and often higher. This factor represents the length of time in which to increase the normal exposure to secure normal results. As an example, let us suppose a subject is arranged and the normal exposure is found to be 1/50 second; then, if the first screen were used 2x it would be necessary to double the exposure, which would be 2/50 or 1/25 second. Similarly the others would be used 4/50, 4x; 6/50, 6x; 8/50, 8x. Many camera shutters do not allow of such a fine range of adjustment as above; however, the average shutters purchased on cameras of today are automatic. As a rule, the speed possibilities are limited to 1/100, 1/50, 1/25, 1/5, ½, 1 seconds, and should the operator require an exposure of 1/12 second he may secure this speed or length of opening by quickly releasing his shutter twice when set at 1/25. Of course this does not give satisfactory results when the subject is in motion, but will illustrate the method of using the shutter to the greatest advantage.

Orthochromatic plates are, of course, much more sensitive to red light than "ordinary" ones, consequently must be handled during loading, unloading, and development with much more care than that bestowed on ordinary plates. They should be developed with pyro soda or pyro metal developers, as it is extremely difficult to secure satisfactory results with metal quinol (M.Q.) on orthochromatic plates. A good formulae for pyro soda and pyro metal is compounded thus:

Pyro Soda—		Metric.
Pyro	2 grains	4 grams
Sodium sulphite	12 grains	24 grams
Sodium carbonate (cryst.)*	22 grains	44 grams
Potassium bromide	½ grain	1 gram
Water	1 ounce	1 litre
Factor	6	

Pyro Metal—		Metric.
Pyro	1½ grains	3 grams
Metal	1 grain	2 grams
Pot Metabisulphide	3 grains	6 grains
Pot bromide	½ grain	1 gram
Sodium carbonate	48 grains	96 grams
Water	1 ounce	1 litre
Factor	9	

These formulae are given in ounce proportions and, if made to the above strength, will answer to the factor quoted below each one, provided that the water is not too cold. This factor is a most useful feature of development, doing away with all guess work. It is used by noting the time in seconds between the flowing of the developer on the plate and the **first** appearance of the image; this time is then multiplied by the factor, the plate and the tray covered for the number of seconds resulting from the multiplication, and at the end of the time specified the development will be at its best for that particular plate or film. Example: Pyro soda developer, factor 6; time from first appearance of highlights to flowing developer 50 seconds. Then 50 seconds × factor 6 = 300; 300 seconds = 5 minutes = time to leave plate in dish covered.

*When sodium carbonate (washing soda) is purchased in crystals it contains considerable water of crystalization which reduced the available Na_2CO_3 considerably. If the dry powder is purchased divide the figure in the formulae by 2.5, which gives 9 grams to the ounce. The pyro is the pyrogallic acid of commerce, usually sold at 25.30 cents per ounce. It is, however, very bulky—an ounce of the loose acid occupying as much space as 15 or 20 ounces of water.

The light used in the dark room should be as low as possible, and the plate or film should not be exposed to a prolonged examination; in this manner there are produced negatives of absolute clearness in the shadows, and in those portions which have been protected during the exposure in the camera by the various appliances needed to hold the plate or film in place. The developed image should be placed under water and rinsed before being transferred to the fixing bath (hypo.).

If a negative is valued it should be protected by a coating of varnish prepared as follows:

Shellac	3¼ ounces
Sandarac	¾ ounce
Mastic	40 grains
Castor oil	1 dram
Rectified spirit	30 oz. (fl.) (.920 to .950)

This is applied when the glass or film is warm (be cautious in warming films; do not let them get any warmer than can be comfortably endured when held against the cheek) and is flowed in a pool on the centre and allowed to flow over the edges and corners. It dries very quickly.

Lantern Slides.—This branch of photography is being used to a greater extent every year by engineers and teachers as it affords a means of presenting illustrations of a subject under discussion to a number of persons at once. There are three methods of making lantern slides which we will discuss in this article; two are direct applications of photography and the other is an indirect application of that science.

The first essential in the making of a slide is a good negative, one that possesses a good range of gradations and is not too thick; the second is an assortment of lantern plates. These plates may be purchased from dealers in great variety, both as regards make and qualities. The British manufacturers are producing the bulk of lantern plates used in Canada. Lantern plates may be purchased in Great Britain from 9d per dozen upwards. The usual retail price in Canada is 25 cents and 35 cents per dozen. Lantern plates are very slow, the average H. & D. speed being about 15. The standard size for lantern slides in the British Empire is 3¼ x 3¼ inches, while in the United States and France they are 3¼ x 4 inches. The method to be employed in slide construction is determined by the size of the negative and the desired opening of the lantern picture.

Supposing the reader to be in possession of a negative, say 3¼ x 4¼ or 4 x 5 inches; as the lantern plate is but 3¼ inches square, it is at once apparent that some process must be resorted to in order that the 4 x 5 negative may be reduced to a proportionate degree, wherein it may be reproduced on the lantern plate. To accomplish this satisfactorily is known as the process of reduction.

An examination of Figure 5 will serve best to illustrate the principle of this operation. The negatve is placed in the centre of a wood or cardboard frame and all light other than that entering through the negative is excluded from the room. If a clear view of sky cannot be procured, one or two thicknesses of white tissue paper should be secured a few inches from the negative. A lantern plate is secured in the ordinary plate holder and the negative photographed. The lantern plate is then developed when it is found that a small positive is formed which has the same proportions as the negative.

If a portion of a negative less than 3 x 3 inches only is required the slide is made by contact, which is accomplished by placing the negative in a punting frame, face up, and then laying a lantern plate face down over the desired portion and exposing to light for a few seconds.

In the matter of lantern slide exposures it will be best found by actual trial; however, as a guide the experimentee may use the following:

For Reduction—

Window in shady position, ordinary negative, average lantern plate F22 ..... 7 seconds.

For Contact—

Candle light, ordinary negative, distance from light to plate 12 inches .....25 seconds.

A lantern plate may be best judged in the developer. A plate which begins to appear in 30 to 40 seconds and is quite dense in 2 to 3 minutes, providing all the high lights remain clear, will, as a rule, give a satisfactory picture on the screen.

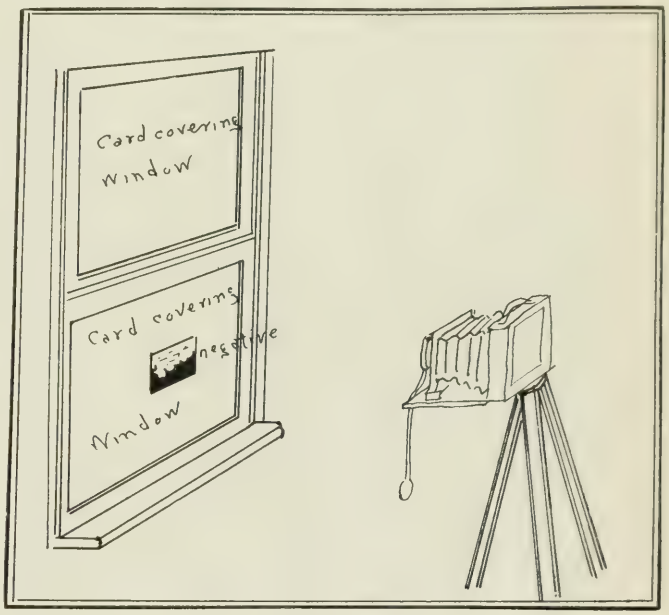


Fig. 4.

The mounting of a slide is a comparatively simple matter; however, it is imperative to have both slide and cover glass thoroughly dry before binding. The mat should be made of paper entirely opaque when held between the eye and a strong light. In placing the thumb spots on a slide it is the usual British method to arrange the slide in such a way that the mat is uppermost, then turn the plate so as to bring the lower portion of the picture farthest from the person, then the two white discs are secured at the two corners nearest to the person. An old lantern maxim is "Face in and sky down, and a mistake will never be made." It will be seen that the foregoing is summed up in the maxim.

It often happens that when a slide is required at short notice a half tone block may be secured from some technical publication or advertiser. The usual size for a cut is 3½ inches on its longest side. If a piece of celluloid is prepared by flowing over it a solution of gasoline and rosin, the resulting surface will have many of the properties of paper and will receive a very presentable impression of the halt tone when inked and placed in a small press such as a copying press or other variety. A pad of newspaper should be placed on top, and if the celluloid is inclined to lay flat the inked cut should be placed face up, then the celluloid face down, and on top of all the pad of newspaper about ¼ inch thick. The celluloid is then masked and bound between two pieces of glass.

Printing.—The majority of negatives are made with the intention of preparing paper prints, and although there is

scope for considerable display of ability in preparing prints, the essential is a good negative. For detail work and a finished appearance the glossy gaslight papers are generally used. The extreme glaze is an after operation. Here again the subject of exposure is all important, and the little table given below is an average:

Source of light.	Distance of printing frame.	Time.
16 c.p. electric	12 inches	40 seconds
Open gas flame (17 c.p.).....	12 inches	40 seconds
Incandescent gas (bright)....	12 inches	20 seconds

This, of course, is for an average negative, that is, one showing clean and clear through the frame and not unduly stained. In development of a print, the image should begin to appear in 15–25 seconds, and be fully developed in one to two minutes. Place the print as taken from the frame face up in the developing tray and flood with cool, clean water, then pour off and quickly flow the developer over the softened print; keep the direct light from reaching the paper by introducing the body in the direct path of the rays. Always rinse the print well before fixing, and when in the fixing bath (hypo) the print should be kept below the surface, thus avoiding brown stains.

The glaze is imparted by placing the well washed print face down on a clean piece of glass and allowing to dry in that position. The print should be well rolled when first placed on the glass.

THE VERTICAL POSTS OF BRIDGES.*

By Prof. Albert Smith.

There is no point in the design of steel structures more loosely defined in specifications and in the standard practice of the profession than the design of compression members for bridges.

Very many careful tests have been made as to the testing machine strength of the common combinations of structural shapes, and lately a great deal of money and labor has been spent to widen the range of these tests to include very large compression members.

This work is very valuable and very necessary. When it it completed, however, there will still be a lack of accuracy in our design of these members. The following questions will still be unanswered:

(a) What is the amount of the secondary stresses?

(b) What is the proper free length to be used in correlating a given design to test formulae?

Practice in regard to the second point varies widely. In the case shown in Fig. 1 most designers prefer to use L_1 for truss plane free length, and L_4 for cross plane free length. These assumptions are very reasonable if one works under the specification of unsupported length, instead of buckling length. It might, however, be urged that this post is supported in the cross plane at the foot of the knee brace and at the top of the floor beam.

For L_2 equal to 16 ft. 0 ins., L_3 might well be 13 ft. 0 ins. and L_4 be 17 ft. 6 ins. The assumed free length might then vary from 156 ins. to 210 ins. For a radius of gyration of as much as 4 ins. the permissible fibre stresses would be, by the common straight line formula:

$$16000 - 70 \times 210/3 = 11{,}100 \text{ lbs.}$$

$$16000 - 70 \times 156/3 = 12{,}360 \text{ lbs.}$$

This difference of 10 per cent. between the permissible fibre stresses calculated on the basis of two different interpretations of the specification would seem to be rather important. If the short length is correct the smaller permissible fibre stress is wasteful.

A much more serious ambiguity exists in the term "free length." In Schneider's Specifications, where "effective length" is used instead of free length, the author specifies that it shall be taken as one-half the distance between connections if the ends are fixed, two-thirds if one end is hinged, and the whole distance if both ends are hinged.

A theoretical definition of fixity might be stated as follows: A condition in which the neutral axis is prevented at the given point from changing direction on account of the tendency to buckle under a compressive load.

But who has determined when this condition shall have been fulfilled? Does a floor beam firmly riveted to the post

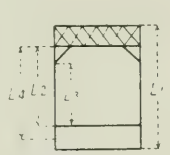


Fig. 1.

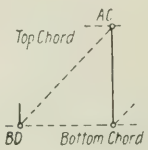


Fig. 2.

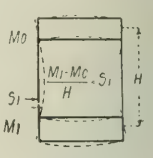


Fig. 3.

fix the direction of its neutral axis, and, if so, at what point of its attachment? Does a latticed strut with a knee-brace fix the neutral axis of the post, and, if so, where—at the bottom of the strut, at the bottom of the knee-brace, or at some point between?

If in the post of Fig 1, dimensioned as above, complete fixity were assumed at top of floor beam and at feet of knee-brace, we should have a free length, by Schneider's Specifications, of $L_3/2 = 78$ ins., and the permissible fibre stress would then be:

$$16000 - 70 \times 78/3 = 14{,}180 \text{ lbs.}$$

This is an increase of 30 per cent. over the most unfavorable assumption.

Mr. C. T. Morris, in the Engineering News of November 2, 1911, calls attention very forcibly to the uncertainty in regard to the assumption of fixity. He appears to assume, however, that the presence of secondary stress and the accompanying point of contra-flexure requires the free length to be measured from the point of contra-flexure to the point of fixity. To this the present writer can not agree. It appears to him that while the position of the free buckling length would be changed on the post, that its amount would be unchanged. The presence of secondary stress in a member is to be considered, not because it lowers the permissible fibre stress, but because it increases the actual existing fibre stress.

Still more serious than the uncertainty as to the point at which fixity may be assumed to exist, is the uncertainty as to whether the empirical formulas into which we substitute are derived from tests on free or hinged end columns. If they are so derived, there would be little question as to the propriety of compensating in the length for fixed end conditions. Obviously we may not substitute half length in fixed end conditions (if we have them, and know it), in a formula arrived at from tests upon flat end columns. Even tests upon hinged end columns can not be considered to show the strength of columns absolutely free to turn at the ends, and should, therefore, not be adopted to fixed end conditions by reducing the length with the factors one-half and two-thirds.

Without excessive difficulty, tests upon members braced in manner as the vertical posts of bridges could be so contrived as to throw enough light upon the subject to enable a committee of one of the national professional societies to draw up a defining specification.

* Paper before Indiana Engineering Society.

The secondary stress in the cross plane is very easy to determine theoretically. The engineer should not think, however, that these theoretical results are exactly true. The Engineering News, in a very able review of the practical aspects of secondary stresses, notes that truss plane secondary stresses are self relieving. It is also to be noted, in regard to cross plane secondaries, that the warping of the truss as a whole, which must take place when a series of posts is bent from the floor beam action, causes the inside half of the diagonals to take a disproportionate stress, which tends to develop an outward bending in the post. The eyebar, or diagonal angle CD, in Fig. 2, will have a stress appreciably greater than that in AB. This excess, multiplied by the arm CD/2, produces a bending moment opposite to that produced by the bending of the floor beam.

It is certainly not possible in contracts with small allowance for engineering, to compute the relief of the secondary stress from this cause. The secondary itself is not expensive to compute. The amount of this relief can never exceed one-half the secondary stress, since it is the imposition of a uniform moment upon a moment varying from zero to a maximum.

There is, however, one thing that the secondary stress calculations for vertical posts can teach us, which is worth while bearing in mind when designing these members. In two examples in Hirei, "Statically Indeterminate Stresses," pages 167-8, the moments M_1 and M_0 are computed for a railway and a highway bridge bent. The change of moment between top and bottom of the post is found to be 52,000 lbs. and 36 lbs. respectively. For heights of 20 ft. and 16 ft., the value of S_1 in these bents is 2,600 lbs. for the railway bridge and 2,250 lbs. for the highway bridge. Remembering that a certain amount of the wind load on the top chord is certain to be carried down the posts, it seems quite possible that there may be a shear of about 4,000 lbs. in the post.

If, then, this post is latticed in the cross plane with single-rivet lattice bars, each rivet of the latticing throughout the whole length of the post must endure a considerable stress. For a shear of 4,000 lbs., and with two systems of 60° lattices, this stress would be 2,000 lbs. × 1.15 = 2,300 lbs. This is not a very large stress for a single rivet, if only it were the average stress in a joint of several rivets. Here, however, the safety of the whole structure depends upon the ability of each of a great number of rivets to bear alone a load of over one ton. Such a reliance upon single units of construction is contrary to the principles of good design.

The conclusion which I wish to draw from these considerations is that the latticing of vertical posts of bridges should all be in the truss plane, in spite of the loss in pin plate metal. Where channels are turned with their webs in the truss plane a web plate should be used to connect them.

LARGE STEEL INGOTS.

Messrs. Cammell, Laird and Co., Limited, of England, have just turned out two very large steel ingots at their Grimesthorpe works, Sheffield. One of them weighs nearly 140 tons, and will form the base of an armor-bending or straightening press for a neighboring firm. It was cast from three furnaces, then reheated and placed under the 4,000-ton hydraulic press, in which its thickness was reduced from 4 ft. 6 in. to 3 ft. 6 in., and the top end, weighing about 40 tons, was cut off. After being again re-heated, it was rolled down in the armor-plate mill to a thickness of 2 ft. 7 in. The second large ingot is an octagon of 1 ft. 7 in., for a gun jacket.

Messrs. Cammell, Laird are at present very busy with naval construction work, including castings for the two battleships now being built at Devonport and Portsmouth, and for the Audacious and other vessels which are in hand at Birkenhead and Fairfield.

A NEW PETROL CAR.

The Leyland Motor Company, of Leyland, England, have recently constructed a new petrol car, which is now in operation at Hepsham. The car is driven by petrol engines and runs on the tramway lines, an adaptation, in fact, of the motor driven 'bus to tramways.

The Leyland Motor Company, of Leyland, near Preston, have constructed the car, in so far as the driving machinery is concerned. It is a single-decked petrol driven tram car, of 55 horse power, and has seating capacity for 37 passengers. The general particulars are as follows:—The transmission is from the four-speed gear box through universal joints to a gear case on one of the axles. The two axles are connected together by a roller chain, and the axle gear case contains heavy spur and bevel gears and reverse gear, the whole running in oil on ball bearings. The ordinary pattern tramway hand brake is fitted, and a large diameter external band pattern foot brake is fitted immediately behind the gear box. The car, which is completely controlled by the driver from either end at will, is built up of angle irons and timber on the usual tramway practice. The body is well finished, all the side windows being made to raise and lower by screw operating gear. Plain varnished seats are placed crossways with a central gangway. The car is lit by elecric light by means of a number of metallic filament 10-candle power 6-volt lamps, supplied by current from a dynamo driven from the engine on the Trier and Martin systems. The length of the car over collision fenders is 31 ft., width over all 7 ft. 7 in., length over corner pillars 21 ft. 6 in., total height 10 ft. 1½ in., gauge 4 ft. 8½ in., wheel base 8 ft., weight of car complete 7 tons 5 cwts. The sub-contractors were as follows:—For car body, the United Electric Car Co., Ltd., Preston; electric light, Messrs. Trier and Martin, London. The approximate cost is $5,250.

At the first trial of the car, Mr. C. B. Nixon, the representative of the Leyland Motor Company, gave some figures on cost of operation, etc., as follows. It was, he said, an ordinary tram car body built by the United Electric Car Company. It was fitted with a 55-horse power four-cylinder petrol motor, capable of developing 60-horse power. As the car was intended to run on a road that had steep gradients, and was somewhat greasy, it was thought better to couple the two axles together with a large driving chain, to get the adhesion of both axles. As to the cost of the running of the car, that remained to be tested, but he thought it might safely be assumed that it would travel eight miles with a gallon of petrol, or at the rate of a penny a mile for fuel. It generally took two units of electricity per car mile, and if the cost was 4 cents per unit the saving in current would be considerable. The cost of maintenance and general running would be about the same as a motor 'bus, 2 cents to 3 cents per mile. The cost of the track must be put against the cost of the rubber tires of a motor 'bus, which would be about 3½ cents per mile. A motor 'bus would do 45,000 miles a year for $1,800 in the cost of rubber tires, but it could be seen that the track could be maintained at less than that amount.

ELECTRIC RAILWAYS OF CANADA.

The electric railway systems throughout the Dominion, in common with other industrial enterprises, have received a large share of the general prosperity of the past year. To state the total of the net profits would be impossible at this early date; the net profits of seven of the more prominent railways, however, amount to $10,500,000.

Several of the western cities have placed electric lines in operation during the year 1911, and these, though giving in nearly every instance satisfactory returns, are not as yet on a profit-making basis. Electric railway construction has not been entirely confined to the west, however, as the central and eastern municipalities have constructed considerable extension work. Among this construction work will be found the extension of the Halifax Tramway Lines into Point Pleasant Park; during this present year it is proposed to increase the efficiency of the service by double tracking the belt line, which will necessitate the laying of about three and one-quarter miles of track, additional cars, increased car housing facilities and the installation of an additional unit in the power plant; the whole involving an expenditure of approximately $200,000.00.

The Montreal Street Railway Company do not report any line extension of magnitude; on the question of expansion along other lines, however, this company has been exceedingly active. During the past year this company secured an amendment of its charter, authorizing the sale, lease or transfer to any person or company of all its undertakings. Following this a meeting of the shareholders was held for the purpose of considering the sale of the belongings of the company to the Montreal Tramways Company; the majority of the stockholders being in favor, the sale was concluded. By thus disposing of the property of the Montreal Street Railway to the Montreal Tramways Company, all the subsidiary companies previously partially controlled by the Montreal Street Railway, together with the latter mentioned company, are all under one control. It is thus hoped that this amalgamation will materially assist to speedily complete negotiations, now under way, for a new franchise.

In Toronto there has been considerable activity with rail laying, but most of this has been confined to the civic car lines. The Toronto Railway Company completed improved car housing facilities and increased the rolling stock by the addition of one hundred double truck cars. Track and overhead construction on various streets, which was completed last year, has given improved traffic handling facilities by allowing the company to change the route of several lines.

As a result of the Dominion census of 1911 the municipality of London, Ont., is entitled to 1.73 miles of additional track. Various routes and localities have been considered for this but no definite agreement has been concluded with the city as yet.

Among the seven companies mentioned above probably none have been so active as the Winnipeg Street Railway Company. 10.84 miles of track with concrete foundation have been laid, thirty large double truck cars have been purchased, 1,134 new poles were erected, and 216,424 pounds of wire with 189 transformers were put up. A new auxiliary steam plant of 12,000 horse-power was constructed during the past year. The company now has auxiliary power to the extent of 20,000 horse-power available in event of a serious break-down at the hydraulic plant.

ELECTRIC RAILWAYS OF CANADA.

Table Showing Comparison Between Different Companies for Year 1911.

City.	Total earnings.	Operating expenses.	Percentage of operating expense to income.	Population of city.	Passengers carried.	Car mileage.	Gross earnings per car mile.	Operating expense per car mile.	Number of miles of track.
Halifax	$ 502,399	$ 256,874	51.97 %	40,081	5,212,257	918,121	54.6¢	28.08¢	14.62
Montreal	4,775,300	2,679,805	56.12 %	466,197	118,258,080	16,117,598	29.5¢	16.95¢	154.36
Toronto	4,851,541	2,652,361	55.2 %	376,240	120,997,844	16,354,871	29.5¢	16.28¢	110.88
London	154,703	93,248	60.2 %	46,177	3,887,598	1,227,285	12.61¢	7.59¢	29.51
Berlin & Waterloo	38,099	15,222	39.9 %	15,192 4,360	734,823	92,134	42.4¢	16.91¢	4.39
Port Arthur & Fort William	172,976	117,496	67.8 %	11,216 16,498	3,557,570	614,015	26.4¢	17.89¢	22.33
Winnipeg	3,829,749	1,900,967	49.64 %	135,430	44,281,245	5,453,432	70.2¢	34.84¢	69.50

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CRITICISM OF MUNICIPAL ENGINEERS.

The criticism of municipal engineers and other officials appears to be as prevalent in England as it is in Canada. Mr. J. A. H. Green, the retiring town clerk of Nottingham, in a recent address condemned the abuse of city officials. Among other things he said: "Those whom we come into contact with in our daily work, and who know what we do for the most part, treat us generously and well. They appreciate the services that are rendered by officials, and they know that officials as a body do their utmost to serve the city to the best of their ability. But it is an intolerable thing that officials as a class should be liable to be branded by those who know nothing, and care nothing, simply for the sake of creating confusion and unrest. I want to protest here as strongly as I possible can against the reckless and indiscriminate abuse of officials as officials."

The above words apply with equal force to the criticisms, which are now so general, of town and city engineers. Municipal councils seem to have no regard for their faithful employees other than to stir up trouble for them. The life of the municipal engineer at best is a hard one. Their work is seldom appreciated, yet the management and construction and design of all the city's affairs are in their hands. An engineer who is employed by a private corporation has a comparatively easy task, for the people he must satisfy are few in number and quite amenable to reason. On the other hand, it seems to be a universal practice for certain members of town and city councils by their constant nagging and lack of fairness to make the life of their engineers a hard thing. We agree with Mr. Green when he says that no word can be said too strong in condemnation of these attacks.

WATER POWER.

Too little attention is paid by the Provincial and Dominion Governments to the conserving of our water power resources. It is true that the Dominion Conservation Commission have made an initial move towards a consideration of the problem, and the recent report compiled by Messrs. A. V. White and L. G. Dennis, and issued by the Commission, on the water powers of Canada, is a very valuable collection of data. This feature of the problem is very necessary, for it is impossible to do much on the conservation question until the requisite data and information are to hand. There is one feature of the conservation question, however, which is lost sight of, and that is the absolute necessity of securing the highest possible economy of water in all water power developments. Our water powers in the future will be too valuable to allow of their waste at the present time. To illustrate a little more clearly what we mean, the total head at Niagara Falls is 212 feet. One of the companies operating there uses of this available head only 136 feet. The turbines in operation have an efficiency of less than 75 per cent., or a combined efficiency of generator and turbine of about 70 per cent. Add to this the fact that very high velocities in the tail-race tunnel are used, or will be used, when the plant is under full development, with an additional preventable loss, and it can be easily seen that a very considerable percentage of the total available power is thrown away. From the standpoint of the company, this is perfectly legitimate and proper, for the whole expenditure on the plant is designed to secure the highest possible rate of interest on the investment. From the standpoint of the

Government or the public, this power is lost in that it cannot be used in any way, and later on this will work serious harm to the consumer.

This same condition is occurring on many, if not nearly all, the hydraulic developments being installed at the present time, and for the reason outlined above. The engineers and the men who are financing these developments are looking to receive the maximum of return from the minimum of expenditure, and for that reason they simply skim off the cream of the development. For instance, let us take a typical example: there may be a fall of fifty feet occurring at a certain spot in a river with an additional ten feet of fall in the 4,000 foot stretch below the main fall. The company takes the fifty foot fall and throws away the other ten feet.

In our opinion the plans of all hydraulic power companies should undergo strict examination by a competent commission of engineers and the company should be forced to use the total available head on the initial development or provide means for afterwards securing the total head. The most efficient forms of hydraulic turbines and generators should be used, and every means taken to secure the maximum possible power from each development. The above extreme measures may not be necessary in the early development of the individual company, but the government should satisfy itself that when the time comes for more efficient development it can be secured without trouble and with no radical change in the original plans.

EDITORIAL COMMENT.

It is evidently time for a revision of the Mining Act of Ontario. At the annual meeting of the Ontario Land Surveyors, held in Toronto February 27th to 29th, the members expressed great dissatisfaction with the way the Act works out with regard to land surveyors, and passed a resolution asking for a clearer interpretation.

* * * *

One of the best services the branches of the Canadian Society of Civil Engineers can do for their respective members is to extend and develop their libraries. The work of the executive committees will be well repaid by attention to this matter in the increased interest of the local members and the increased capacity for service.

* * * *

The growth and perfection of the gas engine is exemplified in its application to the road roller. The gasoline road roller should certainly fill a place in road building throughout Canada. They are economical, easy to operate, require very little water, and the fuel is easy to handle. In the Western provinces, particularly where coal is high, there will undoubtedly be a demand for them. The steam road roller is the product of many years of use and experiment, and as a piece of well-balanced, thoroughly compacted and designed machinery, little improvement can be made on it; necessity and invention have brought it to the highest stage of economy. The gas engine roller is comparatively new, and until it has been subject to some years of use troubles and weaknesses may develop. The field for both steam and gasoline rollers is great, and there is room for both. The local conditions will decide which is the more economical for the individual case.

* * * *

At the recent Ontario Good Roads Convention in Toronto, the Hon. Dr. Reaume, Ontario Minister of Public Works, stated that the Provincial Government had in mind a course of instruction for road supervisors to be given at the Ontario Agricultural College; also that the Provincial Engineer of Highways might deliver a course of lectures at the same place. A short time ago we suggested in the columns of *The Canadian Engineer* the advisability and necessity of immediate instruction for highway engineers, and that this instruction should be given in the engineering faculties of the universities throughout the country. We do not believe that instruction in the making of good roads comes properly in the sphere of the agricultural department. The whole question of road materials and road-making is an engineering question, and we sincerely hope that the Provincial Government will realize this fact and place this work in the Engineering Department of the University.

* * * *

The tie question is becoming a very important one on the railroads throughout the country. With the decrease in available timber ties comes the demand for a substitute for wood. In a recent report the Committee on Ties for the American Railway Engineering Association submitted the following conclusions, which show that, as yet, a perfect substitute for the wood tie has not appeared. The committee states that the concrete tie, a combination of concrete and metal tie, or a combination of asphalt and metal tie, has not yet proved a success because of fracture caused by vibration, excessive weight, and consequent difficulty in handling, and the deterioration of the asphalt filling. A combination tie of steel and wood gives promise of developing an economic substitute. They add that the all-steel tie has proved a satisfactory substitute for the wood ties under heavy medium street traffic. It is durable, line and surface can be maintained, has sufficient resiliency, and can be insulated. The fastening so far in use can, and no doubt will, be improved.

THE PRINCIPLES OF SPECIFICATION AND AGREEMENT WRITING.

By C. R. Young, A.M. Can. Soc. C.E.

(Registered in accordance with the Copyright Act.)

Fourth Article.

SPECIFIC CLAUSES—Continued.

(6) **Classification and Estimating Rules.**—The establishment of definite rules of classification is one of the most difficult tasks of the specification writer. Such rules have their most frequent application to excavation, and when one considers that the materials to be moved may consist of highly variable proportions of everything from quicksand to solid rock, the difficulty of fixing a small number of classes which will secure, at prices named in the tender, fair and just compensation to the Contractor is readily apparent. The usual practice in grading specifications is to divide the excavation into four classes: (a) Solid Rock, (b) Loose Rock, (c) Hard Pan, and (d) Common Excavation. The tests for these classes are based upon the size of the pieces, and the economically-practicable methods of removal, such as blasting, plowing, picking, etc. Because of the indefiniteness of these latter rules and the consequent necessity of relying largely on judgment to determine the class of material, disputes over matters of classification are of the greatest frequency. So common are they that some railways purposely divide all excavation into three, or even two classes, eliminating partly or entirely the necessity of

resorting to the indefinite plowing test for loose rock and hard pan. But this introduces another difficulty. If no recognition is made of hard pan and the relative quantities of common excavation and hard pan are unknown to the Contractor, his bid is likely to be high in order to cover the possibility of having to remove a large amount of hard material at the price for ordinary earth. The remedy would seem, therefore, not in reducing the number of classes, but in making the tests for these classes much more definite than they now are. For example, it has been suggested that the plowing test be modified by requiring a continuous furrow of a certain specified depth to be cut with the four or six horses, whichever it may be, moving at a specified speed and with a certain maximum weight on the plow.

In addition to the variables of hardness and formation, it is necessary to distinguish carefully between dry and wet excavation. It is customary to class all material below the ground water level as wet, but if instead of this level, the level of the water in an adjacent stream or lake is to be followed, it should be stated in the specifications.

The rules of measurement to be followed in making up final estimates should be carefully indicated in the specification. If this were done there need be no disputes between the Contractor and the engineer concerning the method of computing quantities. Whether the length of piles as delivered, or from point to one foot above water level, or the length as left in the work is to be paid for, should be established in the specification. The payment for sections of sewers constructed at so much per foot will depend upon whether the length considered is from centre to centre of manholes or face to face of manhole walls. If the concrete floor on a bridge is to be paid for at so much per square foot or yard, the inclusion or exclusion of the wheel-guard is of importance. Volumes of excavation, concrete or masonry do not total up the same by using the prismoidal formula and by averaging end areas. The manner of computing overhaul, whether it be by diagram or by the centre of gravity method, should be plainly stated. Indefinite units, like the miners' inch, should be avoided, and the cord is not 128 cubic feet in all parts of the continent. Where the work is likely to affect parties in both Canada and the United States, units of measurement applying to the contract in question and which differ in the two countries—the gallon, for example—should be carefully defined. If the weight of cement is to be determined from its volume, the fact whether it is to be loose or packed should be indicated, since in its loose state a given volume of cement weighs only about two-thirds as much as when thoroughly packed.

(7) **Quality of Materials.**—In specifying the particular kinds of materials to be employed, the class names, designations or terms should convey exactly the same meanings to all bidders, or, failing that, they should be carefully defined in the specification. The various masonry classifications, as first class, second class and third class, are variable with the locality and the persons having to do with them. Even such terms as quarry-faced, random rubble or bush-hammered, range ashlar are elastic in their significance, and a fuller specification than a mere name is necessary.

One of the most common faults in specification writing is indefiniteness in describing the grade of materials required. Lacking a knowledge of the particular properties of the materials to be used, many engineers attempt to dispose of the matter by the broad provision that the materials shall be "the best." So long as the engineer and his inspectors are reasonable in their interpretation of what constitutes "the best," there is no objection to the requirement, but when inexperienced inspectors attempt to put a rigidly literal construction on the term "best," it may mean disaster to the Contractor. If one were to require engineering works to contain only timber abolutely free from knots or checks, or steel entirely free from rust, or sewer pipe perfectly circular and free from cracks, blisters and lumps, the cost would be altogether beyond the pockets of the people and wholly out of proportion to the service required. Such a practice is impracticable, because only a small percentage of the output of our mills and factories would come up to this standard, and perhaps in the case of certain mills such material could not be produced at all. If the engineer or his inspector insists upon absolute perfection in the materials enmployed, he either forces a tremendous hardship on the Contractor (or the supply-man who is under agreement with the Contractor to furnish the materials to the satisfaction of the engineer), or he sustains a loss of personal prestige through having to abandon his ruling and accept what can reasonably be supplied. The word "best" should be replaced by a definite description of the properties of the materials required, and if it is retained at all it should be modified by requiring, as expressed by Mr. Wm. B. Bamford, "the usual best to be had in the market supplying the vicinity."

The rules by which the quality of a given material is to be judged should be both positive and negative; that is, they should set forth, on one hand, the minimum desirable quantities, and, on the other, those defects which would be sufficient cause for rejection. Among the former would be the strength, as of cement and steel; resistance to abrasion, as in paving brick; the chemical composition, as of steels; the physical composition, as of cement or asphalt; the weight, as of cement; the size of particles or constituent parts, as of sand, gravel, stones in a masonry wall, or pieces of leather in belts. The latter, or negative characteristics, concern chiefly the imperfections of manufacture, or those natural to the commodity. An excellent example of definite fixing of the maximum defects permissible in material is furnished in the following extracts from a specification for sewer pipe prepared by Mr. Emil Kuichling, and quoted by Professor Johnson in his Engineering Contracts and Specifications:—

> "A single fire-crack which extends through the **entire thickness** of a pipe or special, must not be over two inches long at the spigot end, nor more than one inch long at the hub or socket end, measured in the latter case from the bottom, or shoulder, of said hub or socket. Two or more of such fire-cracks, however, at either end of said pipe or special will cause the same to be rejected.
>
> . . . . . .
>
> "A transverse fire-crack in a pipe or special must not be longer than one-sixth of the circumference of such pipe, nor shall its its depth be greater than one-third of the thickness thereof. Two or more such fire-cracks will be cause for rejection.
>
> . . . . . .
>
> "Irregular lumps or unbroken blisters on the interior surface of a pipe or special of sufficient size and number to form an appreciable obstruction to the free flow of sewage will be cause for rejection. A few small, unbroken blisters, not exceeding one-fouth of an inch in

height and one or two inches in diameter, upon the inner surface, need not reject a pipe or special."

(8) **Quality of Workmanship.**—What has already been said respecting the necessity for definite standards for the judgment of the quality of materials will apply quite as well to the quality of workmanship. It is not possible to wholly avoid the stipulation that workmanship shall be "to the satisfaction of the engineer," but much might be done to render the acceptability of the work and its conformity with the spirit of the specifications more readily apparent to an outside engineer than is now the case. There must, of course, be reason in whatever rules are adopted, and, above all, reason in their interpretation.

Definiteness of requirements might be introduced with respect to workmanship by specifying under the head of straightness, for example, the maximum deviation of a nominally straight member from the truly straight, and under other headings might be set forth the maximum permissible deviation of a sheared, sawn or faced surface from the theoretically correct one, the permissible eccentricity of rivet heads, and the like. For such matters as uniformity of covering or color, as in painting or surface finish of concrete, it would be difficult to make a rule, unless, perhaps, photographs of the finish required were attached to the specification.

As in specifying materials, it is unwise to be unusually exacting in the matter of workmanship. Such requirements, for example, as that the edges of shoe or bed plates shall be planed are absurd, and high bids and discredit for the engineer are the outcome. It is practically impossible to get workmen to greatly change their methods, and, unless the work is unusual and calls for special attention and care, it is advisable to specify the **"customary best"** class of workmanship attainable in that particular kind of construction. If anything better than this is sought, the engineer will probably find that any specification is unworkable, and that he will have to give it his own personal attention throughout.

(9) **Methods of Construction.**—In general, the less said about the methods of construction, the better. The engineer should concern himself about the result rather than the means. Of course, if the work is special and there is only one way known to be practicable, the methods to be followed may be described, but usually it is best to leave the Contractor free to devise ways and means of his own. If he is experienced in the class of work in question, he may be able to suggest methods superior to those of the engineer, from the point of view of both cost and time of execution. It is also inadvisable for the engineer to fix the methods of construction, since if they prove unworkable or result in failure, the Contractor will generally be able to place the responsibility on the engineer, and finally on the Owner.

(10) **Inspection.**—Apart from the general provisions concerning inspection in the general part of specifications, references to this feature are properly made at various places in the specific clauses. In the description of each particular class of work, it is frequently necessary to provide that the continuance of the work beyond a certain stage shall be contingent upon the approval of the work up to that point. Thus, before any concrete or masonry is placed on foundation beds, they must be approved by the inspector, or preferably by the engineer himself; forms should be to the satisfaction of the inspector before any concrete is placed in them, and they should not be removed till he is convinced that such a step is perfectly safe; piles should be driven only in the presence of the inspector, who can then satisfy himself concerning length and penetration. Sometimes, also, it is specified that before any particular material is shipped to the work or to the Contractor's shops it shall be approved by the engineer's inspector. Steel is always inspected (if at all) in this way, and sometimes cement, sand and gravel are examined in the same way. Whatever provisions of this sort are thought advisable should be set forth in describing the particular material or class of work affected.

(11) **Condition of Finished Work.**—As a sort of blanket clause, it is desirable to specify that the finished work shall be, as a condition to final acceptance, in entire accordance with the plans and specifications. This accord should be made to cover not only correctness of detail, but the character of the completed work from the point of view of workmanship and finish,

(12) **Acceptance Tests.**—As a further condition of acceptance, the finished structure, machine or plant should be able to show a certain capacity, performance or endurance, bearing some important relation to the service for which it was designed. Bridges and buildings are frequently required to be tested by the application of loads equal to, or often considerably in excess of, the loads for which they were designed. Pumping engines must show under test a certain specified duty, while engines, motors and dynamos must give a prescribed output of power. Another kind of acceptance test quite different from these is the maximum leakage test, often specified for concrete tanks or standpipes.

(13) **Cleaning Up.**—To ensure sightly surroundings and freedom of the adjacent spaces or thoroughfares from obstruction, it is customary to require that the site of the work shall be properly cleaned up before acceptance. Surplus material, débris, falsework, staging, tools, appliances, and all marks of the Contractor's operations should be removed, leaving the surroundings at least as neat and presentable as they were before construction began.

The series of articles by Mr. C. R. Young on **"Principles of Specification and Agreement Writing"** will soon be complete, and may then be obtained in pamphlet form from *The Canadian Engineer*. Orders will be received at any time.

NATIONAL TRANSCONTINENTAL RAILWAY.

When the National Transcontinental Railway is finally completed and handed over to the Grand Trunk Pacific for operation the total capital expenditure, according to the estimates of the chief engineer of the National Transcontinental Railway Commission, will be $187,781,128. This includes interest charges of nearly nineteen millions. The total interest charges, taking into consideration every phase of the agreement, or, in other words, the net cost to the country to secure the building of the line from Moncton to Winnipeg, Mr. Cochrane in the House at Ottawa, estimated at sixty-five millions. The total capital cost per mile he estimated at $143,015, which means at three per cent. interest an annual fixed charge of about $4,300 per mile. The gross expenditure to complete the road and to provide for all the country's liabilities in connection therewith until, under the terms of the contract with the Grand Trunk Pacific Company, the rental of three per cent. per annum on cost of construction will have to be paid, beginning nine years hence, is estimated at $258,050,000.

THE OCOEE RIVER POWER DEVELOPMENT.

By J. A. Switzer.

The year 1912 will be notable in the annals of Tennessee, because it marks the beginning of a new era—the era of water-power development. The month of January will witness the opening of the first two hydro-electric plants within the State—will see the first long-distance power transmission by means of high-potential electricity within our borders.

These two events, the inauguration of the Watauga Power Company's plant in Carter County, and of the Eastern Tennessee Power Company's in Polk are of greater significance than we are likely to realize. The production of power cheaply—what will it mean to Tennessee? The answer depends upon the distance we attempt to penetrate into the future. For the immediate future, it means the inevitable, and the prompt expansion of our manufacturing interests; since the certainty of obtaining power at a low cost will assuredly attract manufacturing enterprise.

The Watauga Power Company carries off the honor of being the first water-power company in the State to begin operation. But this is relatively a small development, while that of the Eastern Tennessee Power Company on the Ocoee River, but a few days later, in going into service, is entitled to take rank with the great water-power projects of the country.

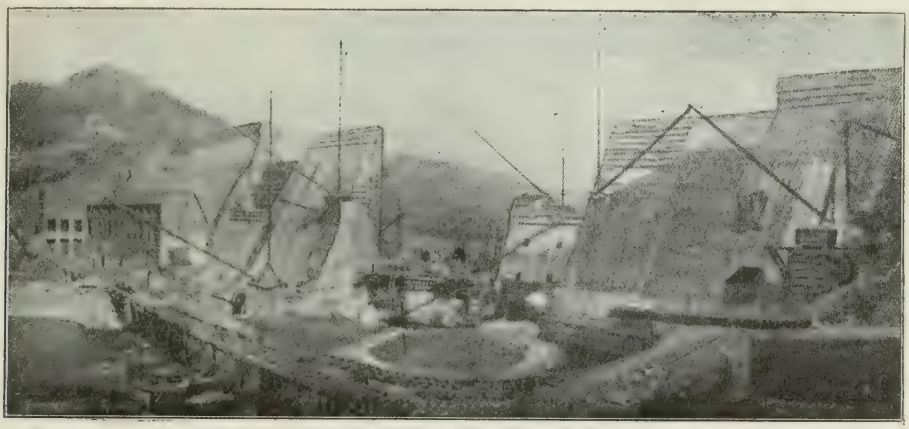


Fig. 1.—Dam at Parksville as it Appeared November 25, 1911.

In many respects the plant at Parksville is replete with engineering interest.

The first impression which the visitor receives is that of the dam as a monument to engineering skill and efficiency. It has been built in a remarkably short time, for the first yard of concrete was not laid until February, 1911. The dam is 110 feet high and approximately 800 feet long, and it required for its construction 155,000 cubic yards of concrete. The work of establishing the construction camp (a small town in itself) was begun in August, 1910, and the first cofferdam was built in October of that year.

By October, 1911, not only had the power house been completed, but all of the machinery had been installed.

The progress of the dam on November 25, 1911, is shown in Figure 1. In this photograph may be seen, near the middle of the dam, two temporary sluiceways. On about December 15 these sluiceways were permanently closed, by filling them with concrete; and the storage of water in the newly created lake began. From that date forward it was a race between the completion of the concrete work and the water. The heavy rains that occurred from December 20 to December 27 caused a great flood of water, and in spite of the relief afforded by the opening of the two permanent sluiceways, the depth of the pool rapidly increased. On December 23 the water stood 20 feet deep behind the dam, and it was gaining depth at the rate of 10 feet a day. However, so excellent was the management that the work proceeded far enough in advance of the water as not to jeopardize the strength of the dam. At the present writing it is expected that the water will reach the crest of the dam at some time between January 10 and 15; and at that time the headgates will be lifted, and the work of generating electrical power will begin.

The pool to be created will extend from the dam upstream a distance of eight miles, will cover an area of approximately 2,200 acres—nearly 3½ square miles—and will contain 100,000 acre-feet of stored water. Of this stored water, only the top layer, so to speak, can be drawn upon for the production of power during the seasons of minimum stream flow. This layer extends from elevation 805 feet (above sea level) to elevation 825 feet (the elevation of the crest of the dam), and is hence 20 feet thick. It will contain about 31,000 acre-feet. Since the low tail-water elevation is 713 feet, the mean head which this storage water will have is about 103 feet; and the amount of power it would generate, if spread over a period of one month, and allowed to discharge for 12 hours a day, would be 9,700 electrical h.p. But the minimum stream flow of the river is about 350 cubic feet per second, and this water, discharging through the turbines for 24 hours per day would generate about 3,500 electrical horse-power. Assuming, therefore, that extremely low water persists for one month of the twelve, the plant would generate 3,500 h.p. during the night and 13,200 h.p. during the day. However, the year will doubtless prove to be exceptional, during which the stream flow will sink to so low a value as 350 second-feet, or even if it did, to remain so low for a period of 30 days. In order, however, to meet such a contingency the company is provided with auxiliary steam power to the extent of 9,000 h.p. Thus the minimum available h.p. will be about 20,000, and ordinary there will be not less than 30,000 h.p. to be developed at the dam site.

Figure 2 exhibits the details of construction of the dam and power house. Above is shown the plan of the dam, and below are sections, one through the power house, the other through the spillway of the dam.

One is struck at once with the curious plan of the dam. Originally the plan was to build the dam straight across the river. But in preparing the foundation of the dam it was learned that a fault-plane existed in the bed rock close to the south shore line of the river. Unless provision were made to meet this condition, the fault would serve to weaken the dam. The original plan was, therefore, modified, and a horizontal arch constructed to carry the thrust of the water

against the dam away from the region of the fault to the rock farther to the south, where secure anchorage was to be had.

Returning to a consideration of figure 2 the section on the line A'A' shows the location of the penstocks, wholly within the dam itself, with the trash-rack guarding its entrance, and the headgate to be operated from the top of the dam, the twin horizontal turbines, each discharging inward through a quarter bend into the draft-tube by which the water reaches the tail-race—the direct-connected generator. Within the dam, behind the turbines, a gallery or passage way is provided. This gives access to the rear bearings of the turbines, and also leads to the valves controlling the two permanent sluiceways which penetrate the dam within the spillway area. The details of these sluiceways are shown in the section on line B'B'. The plan drawing shows the

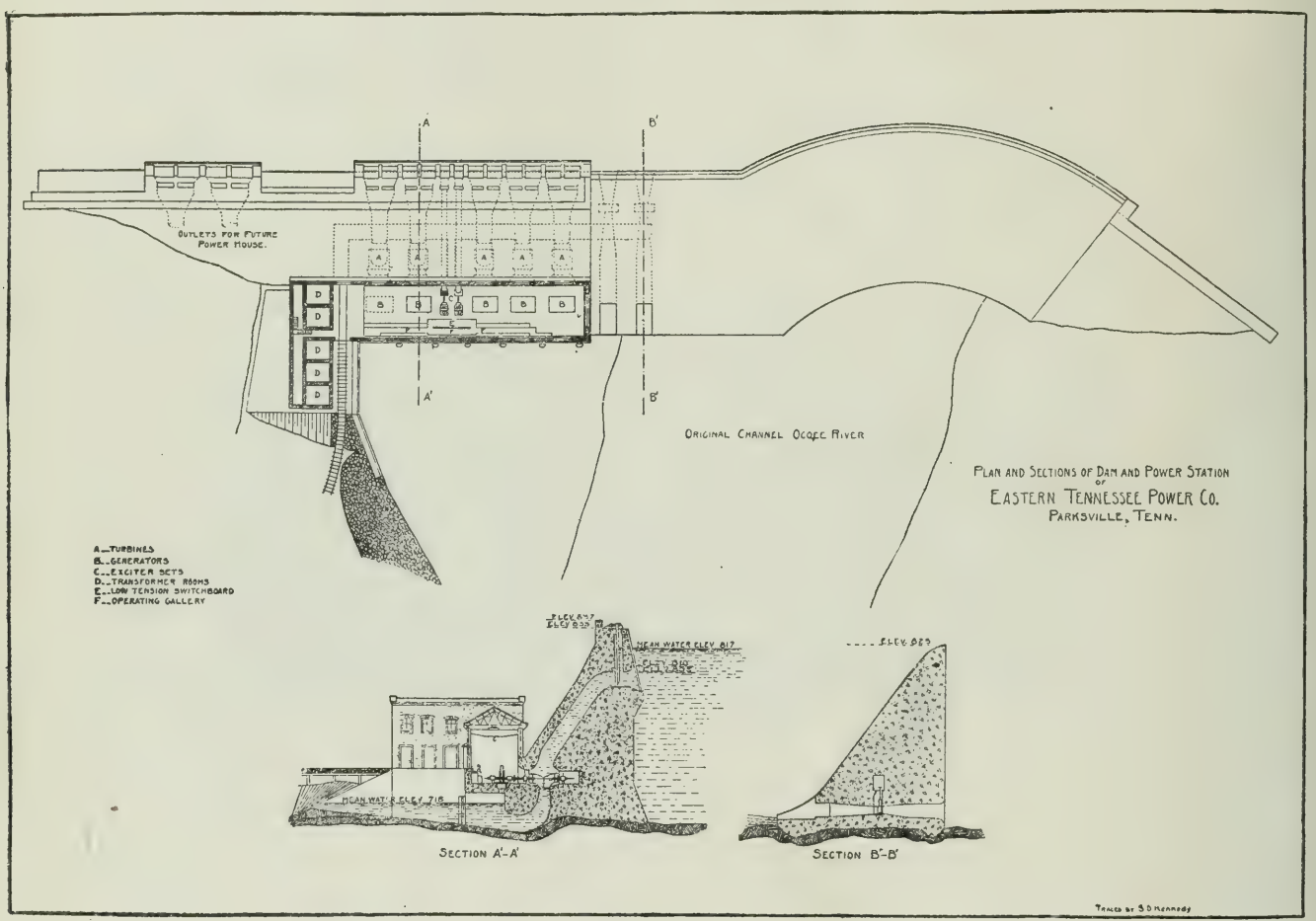


Fig. 2.

location of the four units now installed, and the place provided for a fifth unit for future extension. The turbines are 39 inches in diameter, of the "American" type (that is, inward- and downward-flow turbines). Each pair will discharge about 640 cubic feet per second under a head of 110 feet, and will be capable of developing, under these conditions, approximately 6,000 h.p. The turbines were made by the S. Morgan-Smith Co., of York, Pa.

The turbine governors made by the Lombard Governor Company, of Ashland, Mass., are of interest, because in common with modern turbines themselves, they are the outgrowth of a long process of experimentations and development. Hydro-electric development had for years to wait upon the perfecting of a turbine governor. For the successful utilization of electrical energy, perfect voltage control is essential; and for perfect voltage control, perfect speed control. It would scarcely be in place within the limits of this paper to enter into any lengthy discussion of this subject; but it is of interest to call attention to the office and the importance of the turbine governors.

The turbines at Parksville are known as wicket-gate turbines. This means that the guide vanes which properly direct the water as it enters the buckets of the turbines are a series of steel slats, as it were, arranged around the periphery of the turbine runner. The position of the wickets is controlled by the operating ring; and the operating ring is controlled by the governor. Motion of the operating ring is produced by a piston in a cylinder to which oil under heavy pressure may be admitted. Admission of oil to one end of the cylinder produces motion in one direction, and to the other end in the other direction. Oil is admitted to the cylinder through valves not unlike the valves of a steam engine; and the opening and closing of these valves is in turn controlled by the very slight motion of the stem of the fly-balls of the governor. The fly-balls are turned by a belt from the turbine shaft, and are held by centrifugal force at a predetermined distance from the stem. Any change in speed changes this distance, and in so doing sets in motion the train of operation necessary to open or to close the wicket gates as may be needed to admit more water or less water to the turbine to restore the speed to the normal.

But from this brief description it will be seen that some speed change of the turbine must occur before the governor can act to rectify the speed. This is equally true of steam engines; and it was onsidered a great triumph for water-power development when governors were perfected to the degree of giving as close speed regulation of water wheels as could be had of steam engines.

Even closer voltage regulation is needed, however, than can be attained by the most ideal speed regulation. And this is accomplished at the Parksville plant (as it now is at practically all power sations, whether steam,- water- or gas-driven) by the use of Tirill regulators.

The company can not anticipate who will be its customers, nor where the greatest manufacturing expansion will take place. They are prepared to sell power at Knoxville on the north, and Chattanooga and Rome on the south, and at the intervening cities as well. The power will run the street cars at Chattanooga, and light the city. Power is being contracted for at prices ranging from $20.00 to $30.00 per h.p. per year, depending upon the nature of the service expected. And manufacturers whose requirements would permit of their taking only "off-peak power" could probably buy the power for even less money. The superintendent of the company is Mr. J. A. Cunningham, to whom the writer is indebted for the accompanying photographs.

The plan and sections of the dam and power house are published by courtesy of J. G. White & Co., the well-known firm of engineering contractors. Both the engineering and the construction work have been done by this firm, the former under direction of Mr. R. H. Anderson, resident engineer; and the latter under the direction of Mr. J. G. Munson, construction superintendent.

ALBERTA'S RAILWAY POLICY.

CANADIAN NORTHERN.

(At $20,000 a Mile.)

Onoway Branch to Peace River, 250 Miles	$ 5,000,000

(At $15,000 a Mile.)

Athabaska Landing to Fort McMurray, 175 Miles	2,625,000
Athabaska Landing to Lesser Slave Lake, 100 Miles	1,500,000
Lac La Biche Branch, 40 Miles	600,000
St. Paul de Metis Branch, 100 Miles	1,500,000

(At $13,000 a Mile.)

Bruderheim to Eastern Boundary, 200 miles	$ 2,600,000
Extension Goose Lake Line, 130 Miles	1,690,000
Extension of Camrose Line, 80 Miles	1,040,000
Line West of C. & E., 100 Miles	1,300,000
Brazeau Line to Goose Lake Line, 130 Miles	1,690,000
Total to Canadian Northern Railway, 1,405 Miles	$19,545,000

Of this 150 miles at $15,000 is a revote.
The total new grant is for $1,255 with a guarantee of $17,595,000.

GRAND TRUNK.

(At $20,000 a Mile.)

Bickerdike to Pembina River, 58 Miles	$ 1,060,000
	$ 1,060,000

EDMONTON, DUNVEGAN & BRITISH COLUMBIA.

(At $20,000 a Mile.)

Edmonton to Dunvegan, 350 Miles	$ 7,000,000
	$ 7,000,000
Total, 1,813 Miles	$27,605,000
Less 150 Miles Revote at $15,000 a Mile	1,950,000
	$25,755,000

The above shows at a glance the bond guarantees which the Alberta Provincial Government will give to various railroads to build in that province.

Its railway policy is the most comprehensive that has yet been brought forward. Every part of the province will be given new railways, as a result of bond guarantees. Not alone is the undeveloped north provided for, but the more thickly settled sections of the south will soon secure transportation facilities, for which they have in some cases waited for many years.

The policy involves the guarantee of 1,813 miles of four railway lines involving total cash sum of $25,755,000, and the province holds ample securities in lines to be built as well as tolls, revenues, etc. Should the contingency ever occur that the province would be compelled to take over these lines, they are all through country that will be revenue producing for railways.

The railway lines to be covered by the guarantees of the Alberta Government are as follows:—

The Peace River line from Onoway towards the Peace River, 250 miles at $20,000 per mile.

The road from Athabaska Landing to Peace River, 100 miles of that road at $15,000 per mile.

The road from Athabaska Landing to Fort McMurray, 175 miles, and from that line to Lac La Biche, 40 miles, each at $15,000 per mile.

The road north of the Saskatchewan River running towards St. Paul de Metis, 100 miles, at $15,000 per mile.

The road running south of the Saskatchewan River through Bruderheim to the eastern boundary of the province, 200 miles, at $13,000 per mile.

The road running to the west of Calgary and Edmonton line to the west of Pigeon Lake, 100 miles, at $15,000 per mile.

The extension of the Brazeau line south-easterly to the extension of the Goose Lake line of the Canadian Northern, 130 miles, at $13,000.

The extension of the line from Camrose, 80 miles, at $13,000.

The line from Calgary east of Calgary and Edmonton line, 100 miles, at $13,000.

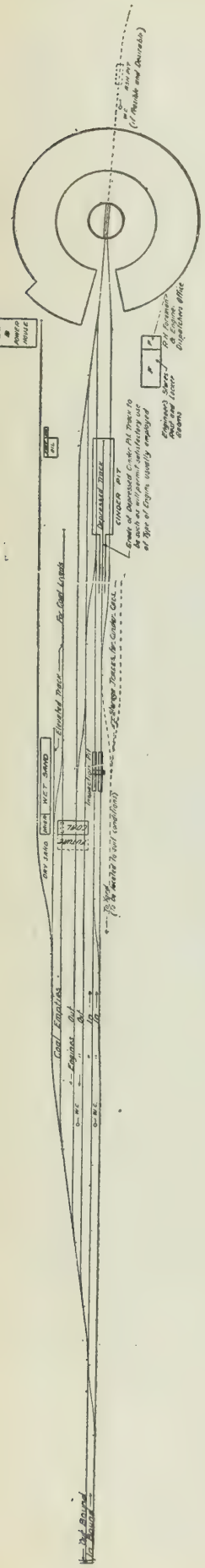
And under the Canadian Northern charter, the extension of the Goose Lake branch of that railway from the eastern boundary of the province to the junction of the Calgary-Vegreville line at the crossing of the Red Deer River, 130 miles, at $13,000.

The total mileage is 1,405 miles of which 150 are revotes covered by former guarantee under federal charters, so that the new lines amount to 1,225 miles.

THE TEMPERATURE OF THE SUN.

In a paper presented to the Berlin Academy of Sciences last year F. Kurlbaum describes a determination of the temperature of the sun, based on observations which he had made in Egypt, near Assuan, in February and March of that year. The brilliancy of the sun's light was compared with the brilliancy of a black body for the wave-lengths 0.651, 0.588, 0.521, and 0.486 μ with the aid of a spectropyrometer consisting of a Holborn-Kurlbaum pyrometer and a spectrum apparatus similar to that which Henning used in 1910. The rays were reflected into the photometer by a plate of magnesia which had a reflecting power of 0.870. The resulting sun temperature would be 5730 deg. Cent. absolute on the Holborn-Day scale, or 6390 deg. Cent. absolute on the Holborn-Valentiner scale.

TYPICAL SITUATION PLANS FOR DIVISION ENGINE TERMINAL.



In the last report of the Committee on Yards and Terminals, for the American Railway Engineering Association is a section on typical situation plans for division engine terminal. The following is abstracted from the report:

In treating this subject, the committee understands its work to be the making of recommendations as to the best arrangement of facilities for the handling of locomotives at terminals rather than as to specifications for exact designs of the various structures involved, excepting as in a general way the characteristics of such structures seem to be more or less suited to the arrangement recommended.

It is also understood that the scope of the committee's work does not include the consideration of shop or repair yard locations.

We submit herewith a typical plan or layout for an engine terminal whose characteristics permit of application equally well to larger or smaller demands practically without limit and without respect to whether the locomotives cared for are all freight or passenger, or in both kinds of service.

We have examined a number of plans of recently constructed engine terminals, and think we have adopted in our plan the best ideas of all, and that we have avoided the manifest errors of some at least of these plans. It must, of course, be recognized that in any case of actual construction, physical limitations as to space and shape of the ground site will impose more or less modification of the plan we recommend, but we think it will come more generally within the possibility of any given set of conditions than any other typical plan that could be suggested.

In locating an engine terminal, the facilities should be placed with reference to the yards and main line in the most advantageous position possible, that is, so that the distance between the engine terminal and the points where engines begin and end their service shall be a minimum, and so that reverse or conflicting movements shall be avoided as much as practicable.

The idea to be kept in mind is the most direct and most convenient, that is, rapid and economical performance of those things required for an engine in its terminal in that sequence which answers all requirements in the order of their accuracy. It appears to us that on the arrival of a locomotive at its terminal, the first imperative demand is likely to be for water, and that this demand is likely to be the last when leaving the terminal for service, and for this reason our typical plan provides for the location of watering facilities accordingly.

After an incoming engine has been protected by receiving water, the next step appears logically to clean its fires or remove it entirely, according to need, and place the engine as quickly as possible in the engine house where the repairs necessary to prepare it for new service may be made, engine cleaned, etc. The cinder pit should be located as close as practicable to the engine house and permit at the same time of engines moving off cinder pit in normal direction, being switched direct to an outbound track without using or fouling turntable, as may often be desired.

It appears logical that the process of coaling should be reserved, if practicable, until just before the engine re-enters service in order that it may do so with a maximum supply of fuel, and also because the cleaning or removal of fire on cinder pit, as well as repairs of engine tank or other repairs, can be accomplished without that interference that might result from having tender filled with coal, and this reasoning dictates that the location of the coaling station should be primarily to serve the outbound tracks. Inasmuch, however, as it may often occur that incoming engines will require coal, the coaling station should be located as indicated on our typical plan, so that coal may also be taken by an engine on an inbound track.

The trestle type of coal dock may be used if desired, if only two coaling tracks are required, and can be located between the inbound and outbound tracks in same relative position as shown in typical plan.

The most convenient and economical arrangement for storing and drying sand is at the coal station, where it may be handled by the same attendants. Sand should ordinarily be delivered to engines passing on the inbound tracks.

It will be observed that the arrangement of facilities permits of large increase in capacity of cinder pit, coaling station, etc., and in this connection the idea of having the coaling station at a busy terminal comprising two independent units making a strong appeal for approval in view of the possibility of one of the hoisting plants suffering temporary disability from breakdown, or other cause.

The location of storehouse, oil house, enginemen's tool and locker rooms need not be arbitrarily prescribed, but should be as close as practicable to the engine house and the cinder pit. However, where any of these buildings are served by their own tracks, those tracks should be so located and connected as not to interfere with the uninterrupted free use of the engine tracks.

A system of ample lighting facilities is important, with lights distributed so as to avoid, as far as practicable, darkness or shadow where men are engaged in work upon engines.

Conclusions.—(1) The engine terminal should be so located as to afford easy access to both main line and yards, with the fewest possible reverse or conflicting movements.

(2) The facilities provided should be arranged to permit of the most direct and rapid handling of an engine in its terminal in the order of its needs.

TREATING SEASONED vs. UNSEASONED TIES.*

By F. J. Angier.

Naturally, the first question which would arise in a subject of this kind is, What is a seasoned tie? When we speak of an unseasoned tie, we mean one freshly cut, or, at least, one that has been recently cut and has lost but a very small amount of the moisture which it originally contained; in other words, the sapwood is so completely filled with moisture that it would be impossible to thoroughly treat the tie until this moisture had been at least partially removed. A seasoned tie, therefore, is one that has been cut for some time and the moisture allowed to evaporate to a greater or less degree.

The time necessary to season a tie so that it can be properly treated varies in different localities, as well as in different seasons. The kind of wood also is of considerable importance. Oak ties, in Illinois, must be air-seasoned six months or more, according to the time of year, before they can be properly treated. Some kinds of ties may be seasoned in three or four months.

For the purpose of illustration, and as a basis for argument, we will assume that it requires six hours to treat a charge of thoroughly seasoned ties and nine hours to treat a charge of unseasoned ties. In other words, it requires one-half longer time to treat unseasoned ties. Of course, the time may vary one way or the other, but we found this to be a fair average. (It should be stated here that the treatment referred to is with a mixture of creosote and zinc-chloride.)

Assuming this to be correct, your attention is respectfully called to the two tables following, one showing the cost of treating in a plant having a maximum capacity of 1,800,000 seasoned ties a year, and the other the cost of treating in the same plant, where the maximum capacity is reduced to 1,200,000 unseasoned ties a year.

Seasoned Ties.

Capacity of Plant 1,800,000 Per Year.

Unloading from cars to ground to season at $0.0070 each	$ 12,600.00
Loading from ground to trams at $0.0055 each	9,900.00
Switching trams at $0.0020 per tie	3,600.00
Loading treated ties out at $0.0065 each	11,700.00
Fixed expenses	23,268.00
Preservatives at 15c. per tie	270,000.00
Fuel (assume ⅓ less for seasoned over unseasoned ties)	5,600.00
Insurance carried on 1,000,000 ties (estimated)	4,000.00
Interest on 1,000,000 ties for six months, or 5% on $250,000.00	12,500.00
	$353,168.00
600,000 more seasoned ties treated than unseasoned, worth $0.044 each (See statement)	26,400.00
	$326,768.00

$0.1815 per tie.

Unseasoned Ties.

Capacity of Plant 1,200,000 Per Year.

Unloading one-fourth from cars to ground to enable prompt releasing of cars, at $0.0070	$ 2,100.00
Loading 900,000 ties from cars to trams at platform and 300,000 ties from ground to trams at $0.0055	6,600.00
Switching 300,000 ties from yard to retorts at $0.0020	6,000.00
Loading treated ties out at $0.0065 each	7,800.00
Fixed expenses	23,268.00
Preservatives at 15c. per tie	180,000.00
Fuel	3,400.00
Insurance carried on 300,000 ties (estimated)	1,200.00
Interest on 300,000 ties, or 5% on $75,000.00	3,750.00
	$233,718.00

$0.1948 per tie.

In each case the total cost of handling is shown from the moment the ties are received at the plant until they are loaded into cars for shipment.

In the case of fixed expenses there are included the salaries of the superintendent, general foreman, office force, engineers, firemen, etc., that is, all labor which would not change one way or the other, whether treating seasoned or unseasoned ties. This amounts to $0.0129 per tie when treating 1,800,000 ties per year, and $0.0194 when treating 1,200,000 ties per year.

In the case of seasoned ties, where no steaming is done, it is assumed that insurance is carried on 1,000,000 ties for six months and that $250,000 will be continually invested at 5 per cent.

In the case of unseasoned ties, we must assume that at least 300,000 will always be in the yard. This stock is necessary to provide against delay to plant at certain times of the year, when traffic is so great that company material cannot be moved with regularity. Also, at certain times of the year, ties will be received faster than they can be treated, necessitating the storing of a portion of them.

It is shown in the table that a treated tie is worth $0.044 to the company. This is obtained as follows:

Untreated Ties.

First cost	$0.50	
Cost of putting in track	.15	
Cost of tie in track		$0.65
5 per cent. interest on investment for six years		.195
Second renewal, end of six years		.65
5 per cent. interest on first investment for six years, and on second investment for six years		.39
Total cost of tie for 12 years		$1.36
Average cost per tie per year		$0.157

Treated Ties.

First cost	$0.70	
Cost of putting in track	.15	
Cost of tie in track		$0.85
5 per cent. on investment for 12 years		.51
Total cost of tie for 12 years		$1.36
Average cost per tie per year		$0.113

Saving per tie per year $0.44.

Untreated ties are assumed to last six years, and treated ties twelve years.

Assuming this to be reasonable, and that 600,000 more ties per year can be treated when thoroughly seasoned, deduct from the cost of seasoned ties the difference between 1,800,000 ties and 1,200,000 ties, or 600,000 ties, at $0.044 each. We have a difference of $0.0133 per tie in favor of treating seasoned ties. This multiplied by 1,800,000, the number of seasoned ties treated per year, represents a saving of $23,940 in favor of seasoned ties.

*Paper presented at the recent convention of the Wood Preservers' Association in Chicago.

In addition there would be a better penetration of the preservatives; therefore a longer life obtained for the ties and the lessened possibility of injury to the wood by steaming. When steaming there is always a large amount of sewage to dispose of, while in non-steaming there is practically none. The disposition of sewage is a difficult problem at most plants, because no matter how it is handled some of it will get into the rivers or creeks and pollute the water to such an extent that damage suits may result. This is entirely avoided when using seasoned ties.

THE CHEMICAL PRINCIPLES INVOLVED IN SEWAGE DISPOSAL.*

By George C. Nasmith, Ph.D.†

It may now be accepted as a fact that chemical action is the basis of every method of sewage disposal. That this is true, the sanitary engineer has been slow to recognize, and he has struggled along for years, endeavoring by empirical experiment to improve existing methods of sewage disposal without having any sound basis for his experiment.

The chemist has come along subsequently, and very frequently has demonstrated the fallacy of his experiments, until it gradually came to be recognized that there were certain principles that must be adhered to in order to obtain fixed results. It was recognized that bacteria, and other forms of life were invariably necessary; that these worked under more or less definite, fixed conditions, and demanded certain treatment; that they could be harnessed to more efficiently perform their functions, and that finally they depended on a free supply of oxygen with which to carry on their work, to completely oxidize the organic matter and create a non-putrescible effluent.

It came to be recognized that one could obtain all sorts of hydrolytic decomposition in septic tanks, or under anærobic conditions, with productions of proteoses, peptones, amino acids, nitrites, hydrogen sulphide, methane and hydrogen; that these decomposition products were still for the most part putrescible, and sometimes more difficult to handle than the raw material from which they were derived, and that after all the complete end products of any method of decomposition depended on the fact that oxidization of carbon gave carbonic acid; of nitrogen gave nitric acid; of sulphur gave sulphuric acid, and of hydrogen, gave water. These are the final products obtained in any completely oxidized sewage. In other words, sewage disposal in the chemical sense might be stated: Organic matter+Oxygen=Inorganic matter+Humus.

The object of all methods of sewage disposal has been to knowingly or unknowingly take advantage of this oxidation process, through the intermediary of living organisms. The methods which have failed are those which have not supplied these micro-organisms with a sufficient supply of oxygen to carry out their functions. Those that have been successful have proved so because they have to a greater or less degree supplied this oxygen in an appropriate manner.

As the object of every method of sewage disposal is to create a non-putrescible effluent, and more recently a non-pathogenic effluent, the anærobic methods, such as that of the septic tank, have failed because of this one fact, that the end products of anærobic action are still putrescible, and must be further treated.

The real biological oxidation methods may be grouped together, since the action taking place in them all is practically the same. These are (1) Intermittent sand filtration, which really is an improvement on the older method of land filtration; (2) Contact beds—single, double, or triple, and (3) Trickling filters.

In all methods of sewage disposal it is deemed advisable as a preliminary to remove as much of the suspended material as possible, by means of the various forms of sedimentation tanks.

In the intermittent sand filtration method, a quantity of raw, screened, or sedimented sewage is distributed over the surface of the bed at regular intervals. This sinks in more or less rapidly, and in a matured bed a similar quantity of liquid, minus the organic constituents, flows off into the collecting tiles below.

In the contact method the sewage flows into beds made up of slag or other material, stands in contact with the filling material for a certain length of time, and is then allowed to flow away.

In the trickling filter the sewage is sprinkled evenly by some form of mechanical device, over the surface of the beds, which are also made up of some coarse material like slag, ling material for a certain length of time, and is then allowed posing the filter.

Now, if the material is sterilized in any of these methods, no action, or only a very slight one, takes place. If the sewage is treated with disinfectants, the same thing occurs; but if these various types of beds are given repeated doses of sewage, the organic matter is gradually converted into inorganic salts, and the filter becomes matured. At the same time it is found that the sand granules, or stone, slag, or other material, becomes coated with a gelatinous layer containing bacteria, organic material and iron. As the gelatinous film becomes thicker, the purifying action is improved.,

In such a matured, intermittent sand filter, Dunbar found that if a gallon of a solution of albumen was poured on to the top of the filter, a gallon of water, less the albumen flowed out at the bottom. That this was the same water he proved by adding readily detected chemicals, such as potassium, iodide or fluorescein to the original solution. When repeated at intervals he found that the sulphuric acid in the effluent corresponded almost exactly to the sulphur in the albumin, while only part of the nitrogen appeared as nitrate, the rest of the nitrogen disappearing as free nitrogen or remaining locked up in the humus, which was formed in small quantities. A considerable portion of the carbon also disappeared as carbonic acid, while the balance was retained in the humus.

The remarkable fact, therefore, became apparent, that a solution of albumen or sewage may leave an intermittent sand filter thoroughly purified in ten minutes. In other words, the organic material in the sewage became absorbed by the gelatinous material covering the granules in the filter. But we know from experience that micro-organisms cannot decompose such material in a few minutes.

By excluding air from the filter, it was found that such purification ceased to take place. By sterilization of the bed, or when disinfectants were added to the sewage, purification also ceased. The principle became fixed that bacteria in presence of air were essential for purification

It was then demonstrated that in a matured contact bed, if quantities of distilled water were added at intervals there would be considerable quantities of nitrates found in the effluent, and carbonic acid would continue to be given off and found in the air of the filter. The conclusion was therefore very obvious. The organic matter was first absorbed by the gelatinous film, and during the periods of rest while in contact with the air, this was decomposed with the

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* Paper read before The Canadian Public Health Association, at Montreal, December, 1911.

† Director of Laboratories of the Health Department, Toronto.

aid of organisms, during which process oxygen was used up, and fresh oxygen drawn into the filter. This latter fact has been proved with the aid of capillary tubes inserted into the beds and connected with monometers. If a contact bed is filled with sewage, and air is blown in at the bottom, the free, unabsorbed oxygen is unable to carry out the necessary oxidizing action, and the sewage is not rendered non-putrescible. The oxygen thus absorbed during intervals of rest seems to be condensed on the surface of the gelatinous film, into some more active form, possibly as ozone, by the high pressure which we know to exist in such gelatinous films.

In the contact method, it was thought formerly that during the time of contact the bacteria were eating up the sewage.

In 1897, Dunbar, in Hamburg, demonstrated in a most convincing manner the fact that the process did not occur gradually during the contact period. He prepared several mature contact beds, and allowed sewage to remain in the first for five minutes; in the second for thirty minutes, and so on. In five minutes the oxygen consumed in the first bed was reduced by 83 per cent., showing, as in the sand filter, that the action took place quite suddenly, and that the time in which the sewage remained in the contact bed was practically wasted. The work, in fact, was done when the bed was exposed to the action of the air, which was exactly the reverse of the conception formerly entertained.

In the trickling filter, the principle of oxidation has been carried to its logical conclusion. In such beds, the sewage is continuously sprayed over the surface by one of the innumerable devices for the purpose. The bed itself is composed of some hard material, preferably of slag, which does not readily weather, and is so arranged that the filling material becomes smaller towards the top and larger towards the bottom, so that humus-like substances formed may be readily washed away.

A sand layer on the surface is advised, since it retains a considerable quantity of organic matter, which is gradually loosened and broken up by the organisms present. The drops of the sewage flow over the surface of the lumps of material, drop on to others, and so on until they reach the bottom. The organic matter as before is absorbed and decomposed by the combined action of micro-organisms, of which the gelatinous films are largely composed, and the oxygen which can penetrate to the interior of the bed at all times.

The effluent contains particles of humus-like material, which is non-putrescible, and being comparatively heavy, is readily sedimented out. The clear effluent is non-putrescible and contains much nitrates. Such beds are able to handle from 150 to 250 gallons of sewage per cubic yard of filling material per day.

Sewages which could not be treated satisfactorily in contact beds were handled satisfactorily by simply trenching the surface of the bed, placing a layer of sand along the bottom of the trench, and allowing the sewage to flow along these trenches, the raised parts allowing free access of oxygen. The contact beds were thus converted into trickling filters, and the results were eminently satisfactory.

The septic tank, which is wrong in principle, except in so far as it may prove useful as a liquefying agent, is already doomed as an integral essential to any method of sewage disposal.

The contact bed, which is on a right principle, wrongly carried out, will also probably soon disappear. The intermittent sand filtration method, which is satisfactory in principle, is very expensive to construct and maintain for a given unit of sewage treated.

Based on purely theoretical principles, and with the experience already gained, in point of economy and efficiency, there is no doubt but that the trickling filter is [illegible] and is bound to displace all present forms.

The sedimentation of the humus-like material from a trickling filter is readily accomplished, and should constitute part of the system in order to obtain a clear effluent suitable for disinfection with chlorine, as well as to remove an obvious physical objection.

The disinfection of raw sewage by chlorine may prove a valuable compromise in some rare instances when other methods of treatment are not possible, but is said to be not working out as well as was expected. It should prove of great value in rendering a clear effluent from biological sewage disposal systems absolutely safe.

In conclusion, I would like to give an almost perfect illustration of nature's method of disposing of sewage, in which the principles of the septic tank, the contact bed, the sedimentation tank, and the trickling filter were involved.

Berlin, Ontario, has a so-called sewage farm. After passing through a septic tank, the sewage passed on to ten acres of heavy clay soil. This became plugged, and the putrefying sewage, after standing for various lengths of time, was allowed to flow into a small creek by making convenient holes in the banks of the sewage basins. The volume of sewage flowing away was sometimes almost as large as the volume of the creek. Consequently, little oxidation took place, and the creek became a foul stream of black putrefying liquid, which flowed from pool to pool, and ultimately into a mill pond about a mile or so below the farm. The pond acted as a second septic tank and sedimentation basin, after the oxidation, which must have occurred to a certain extent during its flow to the pond. The decomposition in the pond was clearly shown by the bubbles rising to the surface and by the odors given off.

The water from the pond fell over a mill wheel, and was churned into foam. The gases present were dissipated by the process, and rising on the outside blackened the white lead paint owing to the hydrogen sulphide present, and causing a marked taint to the flour on the inside.

Below the mill the creek tumbled over a rocky bed for a hundred yards or so. These rocks were covered with a brownish black mat of vegetable matter, which on microscopical examination seemed to be chiefly composed of millions of protozoa, such as paramecium, vorticella, etc., and of bacteria. At the end of this rocky bed, the water was clear, and one mile below, where the road crossed it again the creek was perfectly clear, of a slight yellow color, and contained only traces of free and albuminoid ammonia. The natural action taking place in the creek during its extraordinary flow of one mile accomplished what the sewage works had failed to accomplish.

This process of Nature illustrates the typical methods which we have tried in one way and another to harness. There was the septic tank and sedimentation process going on in the pools and pond; the aeration process taking place in the mill wheel, and the adsorption and oxidation processes in the rocky river bed by the gelatinous growth, analagous to that of the trickling filter.

MEXICAN TRAMWAY COMPANY.

The Mexican Light and Power Company has not been disturbed by political unrest. It is the intention of the company to begin extensions on the tramway lines this year, which, when completed, will mean an expenditure of $5,000,000 gold, while $1,000,000 gold is being expended on extensions to the property of the Light & Power Company.

Dr. F. S. Pearson, New York, is interested in these works.

Metallurgical Comment

T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

FOUNDRY TROLLEY SYSTEMS.*

D. Caehr.

Perhaps the earliest installations of the overhead trolley tems were made in provision houses and ice plants, where cking is impracticable and industrial railway systems out the question, and where traveling cranes covering more ce than necessary in one room or building without offer- practical means of connecting with another, are, there- e, out of place, besides being too expensive.

The advantage of having a track on which the load can easily propelled, without the need of attention to keep clean, and without monopolizing with floor space for a ck, commends the overhead trolley system especially to foundry where floor space is usually at a premium.

In fairness to the industrial railway system it must be ted, however, that unless trolleys used on the overhead tem are operated either automatically, i.e., the load started one place and automatically stopped at another, or unless operator travels along in an attached cage, an aisle of ne kind is necessary, because the operator cannot jump r flasks, molds, castings, in walking along under the lley, etc. Provision is often made, however, so that the lley can be operated from a disance and the aisle need be directly under it.

As regards the cost of installation between the two sys- ns the overhead system usually has a little advantage over industrial railway, if the latter is properly constructed, comparison including switches, turntables and similar cessories in both systems.

In some instances the industrial railway may be more eaply installed, especially where an overhead system would uire special bracing or trussing of the roof or other sur- es from which the track is to be suspended, and where avy loads are to be handled.

In a foundry desigend for and equipped with overhead lley systems a change in the arrangement of the floor ace, to accommodate different classes of work, can be ac- nplished with greater ease and at less expense than in one uipped with an industrial railway, and the flexibility of e former system is simply astonishing, especially when ed with electric power.

As a matter of economy the equipment of a foundry (or y other plant for that matter) should be used as nearly to full capacity as possible. The overhead trolley system bodies superb possibilities for increasing the output of a nt, by bridging over some of the gaps left by installation special cranes with limited spheres.

Take for instance a foundry for ordinary jobbing, cater- g to all classes of work: You will find a department, ere all the heavy work is done, containing either a travel- g crane of 15 to 50 tons capacity or several jib cranes, so ranged that two can be used together on the heaviest work ich is likely to come into the shop, at the same time serv- g the cupola. If this foundry department has a span of to 75 feet, the cost of a traveling crane is equal to the cost of several jib cranes of half its capacity and the service obtained is in favor of the latter, though for convenience, especially in transporting material, the former has no peer.

A monorail system here would be out of question, as it could not be made to cover enough space to handle all the molds, besides requiring an unusually massive roof construction or special structure for supporting the tramrail, which might be in the way, saying nothing of the impracticabliity of carrying heavy loads (over 10 tons) on the lower flange of a single beam.

However, in handling the iron from the cupola to the places where the light floor work and the bench work is done, the traveling crane can render service only to the end of its runway (taking for granted that it serves the cupola), from where the iron has to be handled by an overhead trolley system or an industrial railway, from which in turn it is either transferred to jib cranes, or light traveling cranes, which serve the light floor work department, or else the iron is poured from the large crane ladle into bull and hand ladles, an operation not practical with industrial railway systems unless special ladle cars are used, or special attachments (to support the ladle shank) are secured to the regular cars. With the overhead system such special features are not required.

The trolley system can go further, even in this matter of handling molten metal. By means of switches the trolley with its load (in this case the ladle of iron) can be run on to a jib crane or on to a traveling crane or on to a gantry crane and serve the entire floor space covered by these, automatic provisions being made to prevent it from running off the track, at transfer points. Such a trolley on any of the various jib or traveling cranes, after handling the molds on its floor all day can be made to go to the cupola to get iron and after being used for "pouring off" and "shaking out," can be made to handle the flasks, taking them to and from the proper storage place, and can handle the sand in the same manner, where systems have been designed with all these possibilities in view. Thus, castings can be taken from one floor to the cleaning-room and a load of sand brought back if the bins be near the cleaning department, as they usually are, before the molders report for work, and the number of trips thus reduced to a minimum.

Working very harmoniously with this overhead track system is a scheme in which one end of an I-beam is suspended by a pivotal support, the other end being carried on wheels running on a circular suspended track, on to which the trolley can be run, allowing a large area to be covered without the annoyance of masts or columns breaking up the space.

We have mentioned various types of cranes, but only their functions as a means of conveying have thus far been considered, although the name implies ability to lift (weights) as well.

We see from the foregoing facts that as to flexibility and co-operation with other systems, with the least amount of handling of loads in transferring, the overhead trolley system certainly holds a unique place, and has some decided advantages over the industrial railway to which may be added that loads can be picked up from points outside of the perpendicular and also so lowered, especially where track is high above the ground.

Both systems can be made to run up inclines by proper application of power, although this is seldom necessary in the overhead trolley system because the track can usually be supported so as to be level, regardless of variations in the ground level.

Special attention should be given to the track, which can be constructed in various ways, the simplest form being that of a rectangular bar which is supported from the wall

* Abstracted from Transactions of American Foundrymen's Association.

or ceiling by means of cast iron or malleable iron hangers, the tralleys used being of very simple construction, usually with one or two wheels running on the top surface of the rail, and capable of being readily taken off the track, which is of special advantage where meat hooks and similar attachments are a part of the trolley. This is the most primitive type of overhead tramway system, referred to previously.

Another, but rare type, employs two channel beams arranged either back to back or face to face, with an adequate space between them in which operates that part of the trolley to which the hoist or load is attached. The wheels of the trolley (usually four in number) run on the top flanges (beams back to back), or on the bottom flanges of the beams (face to face), respectively, due provision being made to have the hangers for this type of track also act as separators. It is probably the most expensive kind of tramrail, without having any particular meritorious qualities.

The plain I-beam track is used perhaps more than any other form, the trolley wheels running on the lower flange of the beams, while the supports are attached to the upper flanges. To obtain the most satisfactory results, the beams must be carefully straightened before being erected and the ends should be sawed rather than sheared. Special attention must be paid to splices and switches so as to have a minimum gap at the joints, and curves must be very smooth, particularly so where trolleys are operated at high speed (i.e., from 600 to 800 feet per minute). Any jar due to an uneven track is communicated to the entire trolley mechanism and load, and in motor driven outfits, parts of the machinery are thus often loosened or broken, merely because of a rough and poorly constructed track.

THE CORROSION OF CONDENSER TUBES BY CONTACT WITH ELECTRO-NEGATIVE SUBSTANCES.*

Arnold Philip, B.Sc., Assoc. R. S. M.

At the annual meeting of the Institute of Metals Mr. Philip (Admiralty Chemist) contributed a paper dealing with the corrosion of condenser tubes by contact with electro-negative substances, this constituting the first part of a series of contributions to the history of corrosion that he has promised to present to the Institute of Metals.

The paper is devoted to an examination of the relatively small number of cases experienced by the British Navy in which localized corrosion occurs in condenser tubes made of Admiralty composition, namely copper 70, tin 1, and zinc 29 parts per cent. The author makes the interesting statement —interesting because the causes of corrosion have generally been regarded as so mysterious—but the causes of fully 90 per cent. of the cases of corrosion observed in the establishments of the Royal Navy have long been known.

In the author's opinion the main problems which remain to be solved concerning localized corrosion are, firstly, the explanation of the causes of rather less than 10 per cent. of the cases, which are now observed; and, secondly, the devising of a general means of preventing these and all other cases of corrosion superior to the method of protector bars, etc., of zinc., aluminum, steel, or iron as at present employed.

Mr. Philip includes in his paper a schedule of queries as issued by the Admiralty to those of its officials who are likely to be able to throw any light on the subject of the corrosion of condenser tubes. This list of questions is very similar to the Corrosion Enquiry Form recently issued by the Institute of Metals, and if all who are experiencing trouble with their condenser tubes would fill up the latter Form (which is modeled to some extent on that of Mr. Philip's, and can be obtained from the Institute of Metals, Caxton House, Westminster S.W.) there is little doubt that Mr. Philip's "10 per cent." of mysterious cases of corrosion would be mysterious no longer.

The paper concludes with a consideration in detail of five very definite cases of corrosion of tubes used in the condensers of battleships, torpedo-boats and electric generating plants of the British Navy.

THE EFFECT OF TIN AND LEAD ON THE MICRO-STRUCTURES OF BRASS.*

F. Johnson, M.Sc.

In this paper the author records the results of experiments made with the object of ascertaining the structural relations which exist between lead and tin when present in brass where the ratio of copper to zinc is 2:1.

He found that by itself, tin was thrown out of the solution in the alpha phase (70 copper, 30 zinc) in the form of a hard pale-blue compound (probably $SnCu_4$) some time after solidification of a slowly cooled alloy. Annealing either preceded by rolling or not enabled this compound to again pass into solution in the alpha phase.

In a brass consisting of the alpha and beta phases, where the latter was present in sufficient amount (e.g., Naval Brass and Muntz Metal) the copper-tin compound was much more soluble, being apparently retained by the residual beta.

In an alloy where the beta phase exists in an unstable form (such as the alloy containing 2 parts copper to 1 part zinc) it is insufficient in amount to retain the tin compound which is deposited mainly as a thin envelope or film separating the beta from the alpha phase, thus giving a reticulated appearance to a polished and etched section.

With regard to lead, the author found that this acted independently of the tin, exhibiting behavior similar to that of lead in ordinary brass or in copper. That is to say it retained its individuality and existed in small particles unalloyed with more than mere traces of any other metal, these particles tending to segregate toward the areas last to solidify. In presence of the excess of the beta phase lead is probably held in solution therein.

As a result of the observation the author strongly advocates a thorough annealing of all cast material of the 70:29:1 and 62:37:1 compositions (admiralty and naval brass respectively) before subjecting it to rolling or drawing, in order that the brittle tin compound may be enabled to pass into solution.

FURTHER EXPERIMENTS ON THE CRITICAL POINT AT 470 DEGREES IN COPPER-ZINC ALLOYS.*

Prof. H. C. H. Carpenter, M.A., Ph.D.

In this paper it is shown that the so-called beta constituent in copper-zinc alloys is to be regarded below 470 degrees C. as an extremely minute and uniform complex of alpha and gamma particles. Its structural stability is so remarkable that even after six weeks' annealing at 445 degrees C. no appreciable coalescence of these particles has

* Papers read before the Institute of Metals at the annual meeting.

been observed in an alloy of exactly the eutectoid composition.

When, however, a few crystallites either of alpha or gamma are initially present in an otherwise pure eutectoid alloy, then, on annealing at 445 degrees C., this stability is comparatively easily destroyed. These crystallites constitute nuclei for the deposition of alpha and gamma, as the case may be, from the mixture, and eventually in both cases the final result is the same, viz.: coarse alpha, and coarse gamma, which can be seen with the naked eye, which have characteristic colors, viz.: alpha pale gold, and gamma pale bluish-gray, and which have the same etching properties.

The peculiarly persistent structural stability of the pure eutectoid alloy can be explained by supposing that at the inversion temperature on cooling, the resolution of beta into alpha plus gamma takes place throughout the entire alloy almost, if not quite, simultaneously. This constitutes a favorable condition for the production of the inversion products in an amorphous form, because the forces operative in crystal production do not have time to come into play. This view is in harmony with certain peculiarities which the freshly prepared alloy exhibits both in polishing and etching, which disappear when it has passed into a visibly crystalline condition.

Further, the structural stability of the eutectoid alloy has been so much diminished by the presence of 4 per cent. of aluminum that after two days' annealing at 445 degrees C. it was found to have undergone the typical lamella inversion such as is shown by the iron, iron carbide eutectoid-pearlite. These facts constitute overwhelming evidence that below 470 degrees C. the beta constituent in copper-zinc alloys consists of the two-phase system alpha plus gamma.

PRESERVATION OF TIMBER.

The deterioration of timber by preventable decay causes a heavy demand upon the timber resources of the country. In 1910 nearly 126,000,000 crossties were purchased to make renewals. By the adoption of devices to retard wear and methods to prevent decay, however, the present trackage could probably be maintained with approximately one-half the quantity of wood at present consumed annually for this purpose. To employ measures which increase the average length of time ties may remain in service without decay is equivalent to increasing the supply of timber.

The principal causes of the deterioration of crossties are decay, insect attack, breakage, splitting, mechanical wear, and respiking. By treatment of ties and the use of improver fastenings, S-irons, and similar devices, a mechanical life at least double the present average life of untreated ties may be secured. The treatment of ties to prevent decay, if the methods used are relatively inexpensive, results in a very great saving to the railroads. In the United States the preservatives used for the greater number of the crossties are creosote oil or a solution of zinc chloride, although large quantities of ties are treated with a mixture of the two preservatives mentioned or with crude petroleum. Other preservatives are also used.

COST OF A GRAVEL ROAD.

A convict-built gravel road two miles long graded to a width of 30 ft. and with a sub-grade 15 ft. wide, has been constructed near Kalamazoo, Mich., by the Office of Public Roads, and the following cost records of the work are from the last annual report of Director Logan Waller Page. The road runs through a level to rolling country over a soil of sand and worn gravel. Only a small amount of excavation was required, and this reduced the maximum grade from 3 to 1 per cent. Gravel of very good quality was obtained from a pit 2½ miles from the road and cost 10 cents per load at the pit. Various other items of cost were as follows: Stripping the pit, 0.1 cent per cubic yard; loading, 3.9 cents per cubic yard; hauling, 65.6 cents per cubic yard; spreading on the road, 0.9 cent per cubic yard, and harrowing, 0.2 cent. per square yard. The road was rolled with a horse roller at a total cost of $22, which is 0.13 cent per square yard. The gravel was deposited in two courses; the first course, 7½ in. deep at the centre and 4 in. deep at the edges, was compacted by rolling to 6 and 3 in. respectively, and the second course, 3 in. deep at the centre and 2 in. at the edges, compacted by rolling to 2 and 1½ in. respectively. The compacted surface was therefore 8 in. at the centre and 4½ in. at the edges. The total amount of gravel used was 3,959 cu. yd. The work on this road was done by county prisoners at a cost of 40 cents per 10-hour day. Double teams cost $4 per day, and the total cost of the road to the community was $3,945.15, which is at the rate of 22.4 cents per square yard, or $1,972 per mile. The work comprised 17,613 sq. yd.

ENGINEERING NOTES.

London, Ont.—Authority has been given from Ottawa to organize a field engineers' company and telegraph department. They will be about 200 strong.

Mr. F. W. Farncomb, C.E., of London, Ont., will organize and command the troop.

Montreal, P.Q.—During the past year the inspectors of the civic food inspection department confiscated an enormous quantity of food. Nearly 125 tons of meats were seized; 2,865 calves were taken away from the vendors; 400 gallons of milk and 6 tons of mixed groceries were confiscated. An effort will be made by the Board of Control to have the law amended so that heavier punishments may be provided for offences against the law in the way of offering impure foods to the consumers of the city.

PERSONAL.

Mr. J. J. Ward has ben re-elected chairman of the York County Good Roads Commission.

Mr. C. V. Mitchell has been appointed purchasing agent of the municipal engineering department, city of Toronto.

Mr. John M. Goodell, Assoc. Am. Soc. C.E., editor-in-chief, Engineering Record, on February 26th delivered a lecture on "Technical Literature" before the graduate students in highway engineering at Columbia University.

Dr. L. A. Herdt, of McGill College, Montreal, has been retained by the city of Winnipeg as consulting engineer in connection with the Point du Bois power plant. He is chairman of the Electric Service Commission of Montreal, having been appointed by the Public Utilities Commission of Quebec to represent them on that board.

OBITUARY.

Mr. Fred W. Doty, sen., President of the Doty Engine Works, Ltd., is dead. His death occurred at Goderich, Ont., on February 26th. He is survived by four sons and one daughter.

Mr. C. Nordmark, a Swedish engineer, met death in an accident at Welland, Ont. He was in charge of certain

waterworks being erected at this point by the Canadian Bovine Company, of Toronto. He was struck by a Michigan Central train.

The death of Mr. James Brownlee is reported. Mr. Brownlee was Canadian Pacific superintendent of the division at Kenora, Ont., where his death took place.

The death is reported of Mr. W. K. Watson, a member of the firm of Watson Bros., contracting firm, of Fairview, B.C. Mr. Watson was killed by the swinging arm of a crane striking his head during the construction of a building at the corner of Hemlock and Twelfth Streets, Vancouver.

MEETINGS.

The inaugural meeting of the Victoria, B.C., branch Canadian Society of Civil Engineers, was held on Monday evening, February 19th, and the following officers were elected for current years: F. C. Gamble (chief engineer of railways), chairman; R. W. Macintyre (Box 1290, city), secretary-treasurer. Amongst others present were Messrs. Bainbridge, Apenes, Rognass, Gray, O'Meara, Evans, Hoard, Hughes and Icke; also Mr. Foreman of the Vancouver branch.

The fifteenth annual meeting of the Canadian Mining Institute will be held at the King Edward Hotel, Toronto, on March 6th, 7th, and 8th.

Guests of the Institute from Great Britain and the United States will include Mr. T. A. Rickard, of London, England; Dr. James E. Kemp, of New York, president of the American Institute of Mining Engineers; Mr. J. Parke Channing, of New York, president of the Mining and Metallurgical Society of America; Dr. James Douglas, of New York; Dr. Joseph Struthers, of New York, secretary of the American Institute of Mining Engineers; Mr. W. R. Ingalls, of New York, editor of the Engineering and Mining Journal; Mr. H. B. Winchell; Prof. R. H. Richards, of Boston; E. W. Parker, of Washington.

THE ASSOCIATION OF THE ONTARIO LAND SURVEYORS.

The annual meeting of the above association was held in Toronto on February 27th, 28th and 29th last. The meeting was held in the rooms of the Engineers' Club, King Street West. Several matters of importance to the surveyor and engineer were discussed. Mr. J. P. Whitson and Mr. T. B. Speight presented some facts of interest regarding the Abitibi district and the timber conditions in that country. Mr. C. Dobie gave some information regarding the elementary conditions in that great clay belt. At the close of the session Mr. J. F. Whitson retired from the office of president and Mr. T. B. Speight was elected to that office by acclamation. Mr. James Dobie, of Thessalon, was elected vice-president. The complete list of officers will be published in a few weeks' time as the remaining officers will be elected by ballot.

THE MEETING OF THE GOOD ROADS ASSOCIATION OF ONTARIO.

The convention of the above association was held in Toronto on February 26th, 27th, 28th last, in the building of the York County Municipal Hall, Adelaide Street.

The convention was attended by representatives of every portion of the province. Mayor Geary, of Toronto, extended the civic welcome to the convention. The object of this convention was to frame a policy whereby the highways of the province should be improved and maintained in good order without further delay. Several practical schemes were brought forward and discussed; among these one proposed that all fines levied upon motorists for breaches of the speed laws should be put to road maintenance and kindred improvements. Another proposed that the Federal Government should contribute one-half the expense, one-quarter from the Provincial body, and the balance from the county benefited.

Major Kennedy opened the meeting, and during the course of his address pointed out that Ontario, during the past year, had exceeded all previous years in the matter of good road building. Major Kennedy further pointed out that the rural population were not, in many cases, in a position to afford road improvements and permanent roadways. In Ontario, he stated, one-half of the provincial assessment of $600,000,000 was upon the cities alone, while the remainder, or $500,000,000, was upon the towns, villages and townships of the province. In this connection he pointed out that whereas the cities had to maintain and build a few miles of highway only, the outlying districts were compelled to care for and construct long stretches of roadway. This gentleman did not speak approvingly of the proposed federal highway, stating that in his opinion it was a mistake and a boon to motorists from the United States.

At the concluding session Mr. A. M. Rankin, M.P.P., Colin's Bay, was elected honorary president; Major T. L. Kennedy, president; Mr. N. Vermilyea, Belleville, vice-president; Col. J. E. Farewell, K.C., Whitby, honorary secretary-treasurer; Mr. G. S. Henry, Oriole, secretary-treasurer. These officers, together with the following gentlemen, constitute the Executive Committee for the ensuing year: Messrs. J. A. Sanderson, Leeds and Grenville; C. R. Wheelock, Dufferin; S. L. Squires, Oxford; Dr. Fairbanks, Lambton, and K. W. McKay, Elgin.

Brief addresses were delivered on different phases of the good roads problem by Messrs. J. Armitage, J. P. Griffin and W. C. Bush.

THE CANADIAN NATIONAL ASSOCIATION OF BUILDERS' EXCHANGES.

The sixth annual meeting of the above association was held in Toronto on February 21st, 22nd and 23rd last. The National Association were the guests of the local exchange, the Provincial Builders' and Supply Association of Ontario. The object of this association is to forward and strengthen a feeling of union between contractors, architects and dealers in builders' materials; to provide a means of intelligent consideration in wage matters and to maintain a headquarters where information relative to the building trade may be obtained.

The entertainment of the Canadian society took the form of a smoker and banquet; the latter being held on the evening of February 22nd. In addition to the delegates and the local members, several prominent architects of the city of Toronto attended. Speeches on matters of interest to the builder were made by prominent members and others attending. The officers of the Ontario Association are: President, Mr. George S. Gould, London; 1st vice-president, Mr. George A. Crain, Ottawa; 2nd vice-president, Mr. George Gander; secretary-treasurer, Mr. P. L. Fraser, Builders' Ex-

change, Toronto. The Executive Committee was elected as follows: Messrs A. L. Jex, Cobourg; A. Bohoemer, Ottawa; Walter Davidson, Toronto; T. R. Wright, London; T. R. Somerville, Hamilton; W. A. Hadley, Chatham; R. Sanders, St. Thomas; John L. Youngs, Stratford; Jas. Bogue, Peterborough; T. D. Broom, Woodstock; P. H. Secord, Brantford; W. J. Detweiser, Sault Ste. Marie.

SCIENTIFIC MANAGEMENT.

Mr. Frank B. Gilbreth, whose eminence in the advocacy of scientific management has been universally recognized, is to speak on this subject at an open meeting of the University of Toronto Engineering Society in Convocation Hall on Friday afternoon, March 8th, at 4 o'clock. This address was to have been delivered on February 22nd, but an audience of over 1,000, consisting of members of the society and their friends interested in efficiency engineering, were doomed to disappointment because of Mr. Gilbreth's train meeting with an unfortunate blockade.

Mr. Gilbreth is one of the world's authorities on the scientific manipulation of labor. The problem is of such vital importance to all industrial organizations that the Engineering Society has extended an invitation to all interested, especially to foremen, superintendents and managers, to whom, in varied forms, the subject daily presents itself.

COMING MEETINGS.

THE CANADIAN MINING INSTITUTE.—Annual Meeting held in Toronto, March 6th, 7th, and 8th, 1912, the American Institute of Mining Engineers co-operating; also important delegates of the Institute of Mining and Metallurgy of Great Britain will be present. Secretary, H. Mortimer-Lamb.

NATIONAL ASSOCIATION OF CEMENT USERS.—March, 11th-16th. Annual Convention at Kansas City, Mo. Sec'y, Edward E. Krauss, Harrison Bldg., Philadelphia, Penn.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE; Secretary. Professor C. H. McLeod.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary-Treasurer, R. W. Macintyre

QUEBEC BRANCH—Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—Secretary E. Brydone Jack. Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—Chairman, Geo. H. Webster: Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department. University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President. W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary. H. Mortimer-Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

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CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

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ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

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WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
3- 8	Water Tube Boilers; Automatic Stokers; Turbines; Saskatoon, Sask. .....(S.)	2-15
3-18	Concrete reservoir (2,000,000 gallons' capacity), Moose Jaw, Sask.....(P. & S.)	2-22
3-18	Centrifugal pumps, motors, etc., Moose Jaw, Sask. .....(P. & S.)	2-22
3-18	Valves and Fittings, Moose Jaw, Sask. .....(P. & S.)	2-22
3-18	96,000 ft. of 18-in. Steel Pipe, Moose Jaw, Sask. .....(S.)	2-22
·15	Pavements, Welland, Ont. .....(P. & S.)	2-29

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Calgary, Alta., boiler feed pump and switchboards	Mar. 15.	Feb. 29.	59
Calgary, Alta., sewer and conduit pipe	Mar. 14.	Feb. 29.	59
Calgary, Alta., designs for aqueduct	May 1.	Feb. 22.	70
Calgary, Alta., electric machinery	Mar. 20.	Feb. 8.	68
Edmonds, B.C., steel pipes	Mar. 11.	Feb. 8.	68
Edmonton, Alta., steel highway Bridges	Mar. 15.	Feb. 22.	59
Fort William, Ont., C.I. main; culvert ..	Mar. 7.	Feb. 29.	59
Fredericton, N.B., concrete substructure and approaches and bridges	Apr. 1.	Feb. 29.	59
Green Point, N.B., breakwater.	Mar. 18.	Feb. 29.	60
High River, Alta., schoolhouse.	Mar. 15.	Feb. 29.	59
Kingston, Ont., dormitory, R.M.C.	Mar. 6.	Feb. 22.	59
Milton, Ont., concrete arch and viaduct	Mar. 4.	Feb. 15.	70
Moose Jaw, Sask., reservoir	Mar. 18.	Feb. 22.	66
Moose Jaw, Sask., pumps, motors, etc.	Mar. 18.	Feb. 22.	66
Moose Jaw, Sask., valves and fittings	Mar. 18.	Feb. 22.	66
Moose Jaw, Sask., laying steel water pipe	Mar. 18.	Feb. 22.	66
New Westminster, B.C., dams and excavation work	Mar. 10.	Feb. 15.	59
Oshawa, Ont., street paving	Mar. 11.	Feb. 29.	70
Ottawa, Ont., steel hopper scows.	**Mar. 11.**	**Feb. 22.**	**59**
Prince Albert, Sask., cast-iron pipe ..	Mar. 8.	Feb. 29.	72
Prince Albert, Sask., sewer pipe.	Mar. 15.	Feb. 29.	68
Saskatoon, Sask., electrical equipment ..	Mar. 22.	Feb. 29.	68
Saskatoon, Sask., Portland Cement ..	Mar. 15.	Feb. 29.	70
Saskatoon, Sask., labor on storm sewers ..	Mar. 29.	Feb. 29.	72
Saskatoon, Sask., sewer and water construction	Mar. 29.	Feb. 29.	72
Saskatoon, Sask., superstructure Y.M.C.A. building	Mar. 8.	Feb. 29.	60
South Gloucester, Ont., brick veneer presbytery	Mar. 15.	Feb. 29.	60
St. Andrew's, N.B., school house.	Mar. 11,	Feb. 22.	60
St. Catharines, Ont., church ..	Mar. 12.	Feb. 22.	60
Toronto, Ont., Coxwell Ave. subway	Mar. 7.	Feb. 15.	70
Toronto, Ont., Barton Ave., sewer	Mar. 12.	Feb. 22.	72
Toronto, Ont., rails, ties and fastenings ..	Mar. 19.	Feb. 29.	68
Vancouver, B.C., water pipe	Mar. 20.	Feb. 29.	60
Vernon, B.C., vitrified pipe sewers	Mar. 11.	Feb. 22.	60
Victoria, B.C., St. John's Church edifice	Mar. 5.	Feb. 15.	60
Welland, Ont., pavement	Mar. 18.	Feb. 29.	72
Westmount, Que., sewer, paving.	Mar. 11.	Feb. 22.	70
Winnipeg, Man., gate valves ..	Mar. 7.	Feb. 22.	60
White Rock, B.C., quarantine station	Mar. 15.	Feb. 15.	59
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., cables	Mar. 25.	Feb. 15.	60

TENDERS.

Belleville, Ont.—Tenders will be received by A. W. Chapman, Esq., County Clerk, Belleville, up to March 13, 1912, for furnishing one concrete mixer. Specifications and full particulars obtained at the office of the County Engineer, Belleville.

Calgary, Alta.—Tenders will be received until March 15th, 1912, for approximately 300 (three hundred) waterworks valves, ranging in sizes from 4 inches to 16 inches. Full particulars at City Engineer's office. J. M. Miller, City Clerk, Calgary.

Carp, Ont.—Tenders will be received until March 21st, 1912, for the erection of a new church in the village. Building to be of brick with concrete basement. Tenders will be received for the cement work and the remainder of the building separately. Plans and specifications can be seen at the Methodist Parsonage, Carp, or at office of Horwood, Taylor & Horwood, Architects, 130 Sparks St., Ottawa. T. E. Argue, Carp, Ont.

Columbus, Ont.—Tenders will be received by the town clerk, Columbus, until noon March 18, 1912, for the construction of twelve reinforced concrete bridges in the township of East Whitby. For plans, etc., apply to Reeve Gifford, Cedardale, Ont., or Messrs. Bowman & Connor, Engineers, 36 Toronto Street, Toronto.

Fredericton, N.B.—Tenders will be received until March 18th, 1912, for a bridge to be built at Stone Ridge, York County, with concrete abutments, and to consist of one covered Howe truss span 123 feet in length. A pipe culvert is to be constructed at the McKenzie Hollow Embankment, in the parish of St. Mary's, York county, tenders closing on April 3rd. Tenders are being asked for the construction of a pipe culvert at the Pokiok Embankment in the parish of Brighton, Carleton county, tenders closing on March 25th. A new bridge is also to be erected at Upham, King's county, bridge consisting of one span 86 feet long, covered Howe truss, and to have concrete abutments. Harry M. Blair, Secretary of the Provincial Board of Works.

Kamloops, B.C.—Tenders will be received until March 7, 1912, for the construction of a covered concrete reservoir, capacity 1,500,000 gallons. J. J. Carment, City Clerk, Kamloops. (See advt. in Can. Eng.)

Moose Jaw, Sask.—Tenders will be received by the City Commissioners up to 10 a.m., March 30, 1912, for the following:—Contract "A"—One 1,500 K.W. A.C. steam turbo-generating set; contract "B"—One 500 K.W. A.C. generator, direct connected to Diesel Oil Engine. Full particulars and specifications can be obtained on application to J. D. Peters, Electrical Superintendent, Moose Jaw.

Moose Jaw, Sask.—Tenders will be received until March 25, 1912, for supplying and erecting two prime mover equipments, an electric lighting equipment, a transmission equipment and accessories for headworks pumping station. E. B. Bonnell, City Clerk, Moose Jaw. (See advt. in Can. Eng.)

Moose Jaw, Sask.—Tenders will be received until March 18th, 1912, for the supply and delivery of certain valves, fittings, pipes and specials, to be used in connection with the laying of 18-in. water main from Sandy Creek to Moose Jaw. All information may be obtained on application to the city clerk, Moose Jaw, or at the office of Walter J. Francis & Co., Consulting Engineers, Montreal.

Merid, Sask.—Up to March 24th, 1912, tenders will be received for the following: 1 road grader, 6 wheel scrapers, 12 slush scrapers. L. W. Atkinson, Merid, Sask.

Niagara Falls, Ont.—Tenders will be received until April 1st, 1912, for the construction of a modern city service hook and ladder truck, horse-drawn, for the city of Niagara Falls, Canada. W. J. Seymour, City Clerk, Niagara Falls.

Ottawa, Ont.—Tenders will be received until March 12, 1912, for the supply and delivery of valves required by the corporation. Newton J. Ker, City Engineer, Ottawa. (See advt. in Canadian Engineer.)

Ottawa, Ont.—The Corporation of the city of Ottawa, municipal electrical department, invite tenders on meters, transformers, incandescent lamps, arc lamp globes, carbons, and sundry supplies, tenders to be received until March 11, 1912. Specifications may be seen at the office of J. E. Brown, Electrical Supt., City Hall, Ottawa.

Ottawa, Ont.—Tenders will be received until April 1st, 1912, for the construction of an extension to Breakwater at Reed's Point, Lorneville, St. John County, N.B. Plans, specifications, etc., can be obtained at the offices of E. T. P. Shewen, Esq., Dist. Engineer, St. John; Geoffrey Stead, Esq., Dist. Engineer, Chatham, N.B.; the Postmaster at Lorneville, N.B., and the office of R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Ottawa, Ont.—The Dept. of Public Works invite tenders up to Wednesday, March 20th, 1911, for dredging required at Cheticamp, N.S. Combined specification and form of tender can be obtained at the office of Secretary Desrochers, Dept. of Public Works, Ottawa.

Sanford, Man.—Tenders will be received until March 23rd, 1912, for the removal of about 20,000 yards of earth from the bottom and sides of ditches on the road allowances in Tp. 8, R. 2, 3 E. Plans and specifications may be seen at the offices of C. A. Millican, 428 Main Street, Winnipeg, Man. H. Grills, Sec.-Treas., Municipality of Macdonald, Sanford.

Toronto, Ont.—Tenders will be received until March 9, 1912, for the various trades required in the erection of a building for the Union Bank of Canada at Sunnyside. Plans and specifications and all information may be obtained at the office of the architects, Darling & Pearson, 2 Leader Lane, Toronto.

Toronto, Ont.—Tenders for the works (other than steel bridges) necessary to the complete construction of the roadbed, ready for the ties and rails upon that section of the Temiskaming & Northern Ontario Railway Commission's Railway, extending from Earlton to Elk Lake, will be received until March 20th, 1912. All information may be obtained at the office of the chief engineer of the commission, North Bay, or at the office of A. J. McGee, Secretary T. & N.O. Railway Commission, 25 Toronto St.

Toronto, Ont.—Tenders will be received until noon, March 26th, 1912, for the supply of electrical equipment for pumping station, sewage disposal works. Plans, etc., at the office of the City Engineer, Toronto, G. R. Geary (Mayor), Chairman Board of Control, City Hall, Toront. (See advt. in Can. Eng.)

Victoria, B.C.—The Government of British Columbia is inviting competitive plans for the new provincial university to be situated at Point Grey. Only Canadian architects can compete. Specifications call for buildings aggregating in value $1,500,000. Particulars, etc., may be obtained from the Minister of Education, Parliament Bldgs., Victoria, B.C.

Victoria, B.C.—Tenders will be received until March 12th, 1912, for the erection and completion of a high school building on Fernwood Road and Grant Street. Drawings and specifications may be seen at the office of C. Elwood Watkins, Architect, Victoria.

Victoria, B.C.—Tenders will be received until March 12th, 1912, for the erection and completion of a High School building on grounds situated on Fernwood Road and Grant Street in City of Victoria. Separate tender will be required of the electrical equipment. Drawings and specifications at the office of C. Elwood Watkins, Architect, Victoria.

CONTRACTS AWARDED.

Brantford, Ont.—Messrs. Schults Bros. have received the contract for Brantford's new Y.M.C.A. Building will cost $95,000.

Calgary, Alta.—Messrs. McNeil & Farmer have the contract for the building of a warehouse to cost $60,000. Owners, Nicholson & Bain.

Cap St. Ignace, Que.—Wharf; Misael Bernatchez, of Montmagny, P.Q., at $11,440.

Devil's Island, N.S.—Extension to breakwater; Obed A. Ham, of Mahome, N.S., $26,984.

Goderich, Ont.—J. H. Tromanhauser, of Toronto, has been awarded the contract for the erection of the new marine tower for the concrete elevator of the Western Canada Flour Mills Company. The piles and other material will be supplied by the Goderich Lumber and Milling Company. The elevator has a capacity of 600,000 bushels.

Goderich, Ont.—Wharf; Mr. S. F. Whitman, 38 Victoria St., Toronto, $35,427.90.

Guelph, Ont.—The contract for the plumbing in the new Y.M.C.A. building has been awarded to Messrs. Stevenson and Malcolm. Mr. F. Smith will install the heating apparatus.

Hamilton, Ont.—The Asphalt and Supply Co., of Montreal, P.Q., have been awarded the contract to furnish this municipality with asphaltic road materials.

Lloydminster, Sask.—Public building; F. E. Healy, Picton, Ont., and Joseph M. Piggott, Hamilton, Ont., $27,500.

Meaford, Ont.—Construction of extension to East Breakwater, removal of Lon West Breakwater, and dredging at Meaford; Gideon Kastner, Wiarton, Ont., $36,700.

Montreal, Que.—The Foundation Company, Ltd., 76 Bank of Ottawa Building, have been awarded a contract to construct a dam and small bridge, about five miles from Bankhead, Alta., on the Cascades River. Operations to commence at once.

Moose Jaw, Sask.—The contract for the erection of the Boys' College building of the Saskatchewan College has been awarded to Messrs. Hazelton and Wain, of Winnipeg, Man., and not to Messrs. Clayden Bros., as announced last week. These latter gentlemen canceled their agreement owing to a mistake in their estimate.

Ottawa, Ont.—Successful tenderer for water intake to cost $32,000, A. J. Dupius Co., Detroit. 60-in steel pipe, 500 feet long, ½-in. plate and equipment.

Saskatoon, Sask.—Messrs. Robinson & Foster, Spokane, have received the contract for the construction of a substructure for a subway under the C.N.Rly. Company's tracks at 23rd Street. Contract price, $50,027.

Steveston, B.C.—Jetty at mouth of Fraser River, B.C.; the Sinclair Construction Co., 1016 Sixth Ave., New Westminster, B.C., $171,350.

Toronto, Ont.—The contract for the construction of a cold storage warehouse for the Swift Canadian Co. at West Toronto, has been awarded to Messrs. Wells & Gray, Ltd., 315 Confederation Life Bldg.; total cost about $200,000.

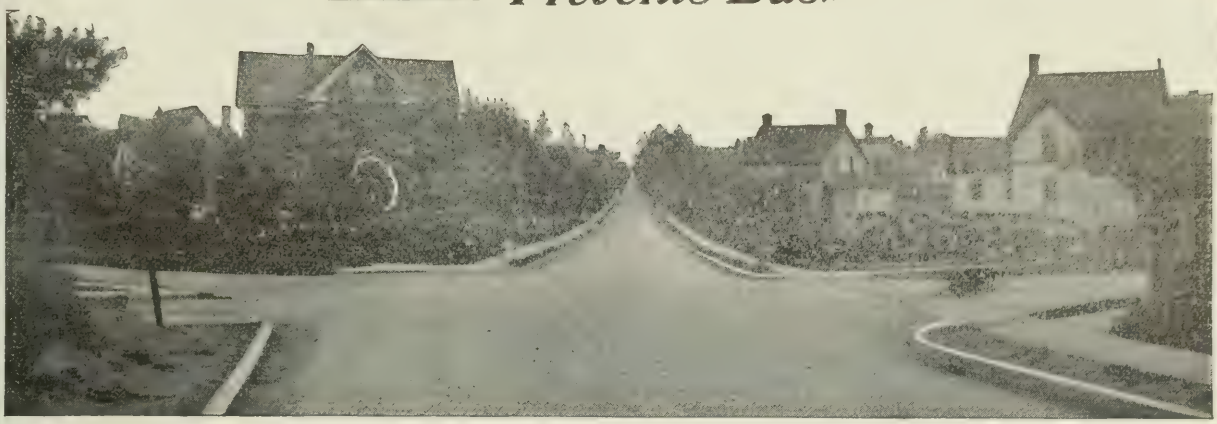
Henry Hope and Sons of Birmingham, England, for whom Mr. Alex. Young, of 45 King St. W., Toronto, is Canadian agent, have been awarded the contract for all the metal sash for the new Bank of Toronto building, Bay and King Streets, Toronto. The sash for the basement, main, mezzanine, and first floors will all be of solid bronze.

Toronto, Ont.—Toronto Junction main sewer, section No. 4, Bloor St. tunnel; Messrs. Orpen Co., Toronto, $28.33 per lineal foot. W. A. Littlejohn, City Clerk.

Victoria Harbor, Man.—Breakwater; the Fort Garry Lumber Co., Winnipeg, $14,500.

Tarvia

Preserves Roads
Prevents Dust



Lancaster St., Berlin, Ont. Constructed with Tarvia X Modern Pavement

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TARVIA is a powerful binder for the surfaces and foundations of macadam roads. fills the voids and locks the stone in a tough durable, plastic matrix.

A Tarviated surface is dustless and clean. It sheds water readily and is dry immediately after the rain, so that pedestrians are not inconvenienced. The surface never gets muddy or dusty.

On account of the Tarvia matrix, these roads will bear heavier automobile traffic than plain macadam because the surface yields instead pulverizing under the strains. The Tarvia matrix prevents internal movement and grinding.

The plasticity of the Tarvia also makes these roads very quiet. Horses' hoofs make almost no sound on a Tarviated road. Tarvia is waterproof, and Tarviated roads, therefore, are protected against damage from torrents on grades.

Tarvia has no odor except when being applied. After it hardens, it has no injurious effect on shoes, clothing or vehicles. The cost of using Tarvia is not a factor for consideration, because it has been repeatedly demonstrated that it is cheaper to maintain a dustless road with Tarvia than a dusty one without it. Maintenance economies more than balance the additional cost.

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RAILWAYS—STEAM AND ELECTRIC.

Athabaska Landing, Northern Canada. — The Canadian Northern Railway have laid steel to within eight miles of this point. In the last eight miles there are eleven or twelve trestle bridges required. It is not likely that the laying of the steel will be completed before July, 1912.

Berlin, Ont.—The Lake Erie and Northern Railway has been sanctioned by the Railway Commission and the Minister of Railways. The route is from Port Dover to Berlin via Paris. It is to be a steam road.

Brandon, Man.—The Canadian Pacific Railway are preparing plans for considerable improvement to their property in this city. The improvements contemplated provide for two distinct yards, one for incoming trains and the other for outgoing trains. The improvements extend from the eastern limits of the yards to the western limits, a distance of two miles.

Montreal, P.Q.—The Grand Trunk Railway System have ordered 250 refrigerator cars from the Canadian Car & Foundry Company, and 250 from the American Car & Foundry Company. 250 automobile cars have been ordered from the last named firm an and equal number from the Western Steel Car & Foundry Company.

Province of Nova Scotia.—The Canadian Pacific Railway has commenced the work of replacing all the old bridges on the D.A.R. with modern structures. Mr. Ripley, one of the C.P.R. engineers, has a staff at work at Kentville, Nova Scotia, and already a number of smaller bridges have been replaced. The bridge over the Avon River at Windsor will be replaced by a larger one.

Niagara District.—The Canadian Northern Railway plans for this section of the country call for an extension of the Niagara, St. Catharines and Toronto Railway System in such a manner as to serve the fruit belt around Niagara-on-the-Lake.

Ottawa, Ont.—A group of English capitalists have held a conference with Mr. R. H. McElroy, of Carleton, Ont., with a view of taking over the stock of the proposed Kingston, Smith's Falls and Ottawa Electric Railway Company.

Province of Saskatchewan.—The Canadian Pacific Railway are about to install 3,200 miles of additional telegraph wire in this province. Three thousand miles will be of copper and the remainder of iron. The following gives in detail where the new wires are to be hung: (1) Copper wire from Winnipeg to Port Arthur. (2) Copper wire from Winnipeg to Moose Jaw via Arcola. (3) Two copper wires from Moose Jaw to North Portal, a distance of approximately 310 miles. (4) Copper wire from Bulyea to Neudorf. (5) Iron wire from Stoughton to Arcola, 80 miles. (6) Iron wire from Vale Port to Bulyea. (7) Heavy copper wire from Saskatoon to Calgary, via Wetaskiwin, about 425 miles.

St. Thomas, Ont.—City Engineer Baker has submitted an estimate of the cost of fixing up the local street railway system. His figures, which were as follows, will be considered at a special meeting to be held in the near future:

Repairing the Road Bed and Overhead Construction.

30 lightning arresters at $7	$ 210.00
Labor on same	20.00
6 miles wire, at 16c.	2,050.00
Labor putting up	200.00
15,500 feet strand wire	350.00
Labor on same	150.00
50 straight line hangers	50.00
350 ears at 35c. each	125.00
350 studs	15.00
150 poles, set and painted, at $7.00	1,050.00
1,200 ties at 60c. each	720.00
Labor putting in ties	300.00
1,500 pounds of spikes	36.75
Repairing bonds	100.00
	$5,376.75

Mr. Baker estimated the cost of repairing the present rolling stock at $2,000.

Western Canada.—A rumor is current in Eastern Canada to the effect that $5,000,000 of French capital will construct a line of railways from the Peace River to the Pacific. The company has taken the name of the Pacific and Peace Railway Department Syndicate. The distance is about 480 miles.

Winnipeg, Man.—The Canadian Pacific has purchased a site of 1,800 acres in East Kildon, a suburb of Winnipeg, the property to be used for the new yards of the company.

LIGHT, HEAT AND POWER.

Chats Falls, Ont.—The hydro-electric authorities are taking steps to expropriate these falls as a source of available power. These falls are owned by the Hon. William Harty, of Kingston, former Liberal member of Parliament, who is said to have secured them from the late Laurier Government for $60,000.

Kingston, Ont.—Mr. C. C. Folger has presented a report on the operation of the municipal power plant for the year 1911. In this report attention was drawn to the fact that the increase of gas at consumers' meters showed 5,015,500 cubic feet, while the electric output increased 74,114. The report showed that the amount received per 1,000 cubic feet, including rentals, was 1.09. The amount received per 1,000 cubic feet, rentals deducted, was 98. The cost at the consumers' meters, per 1,000 cubic feet, was 47, and at the station meter 43.2c. The total revenue from gas rentals was $5,025.01. The total amount of gas manufactured at the station meter was 50,156,000 cubic feet, and at the consumers' meters, 41,577,000 cubic feet. Plans are at present being prepared for a complete reorganization of the entire purifying plant, it being the intention to install the latest type of overhead dry lute purifiers, with modern connections. The electric distribution will need some overhauling on account of the increased output. The electric generating end will require some additions in the immediate future as the 300 K.W. alternating current machine is taking over 200 K.W. and the direct current machine is taking a full load.

Moose Jaw, Sask.—Among certain by-laws to be submitted to the ratepayers will be found one calling for the expenditure of $225,000 on improvements to the municipal electric lighting system.

Niagara Falls, Ont.—A movement is under way to have the falls illuminated by electricity during the evening hours. Senator Gittins, of Niagara Falls, N.Y., has presented a bill at Washington for $50,000 to pay the United States share of the expense. It is proposed to spend $100,000 on a permanent means of illumination and allow $5,000 per year for the upkeep of the same. It is to be an international affair.

Sherbrooke, Que.—The Light, Heat and Power committee are discussing the question of withdrawing the supply of power now being supplied to Lennoxville. The Sherbrooke Railway and Power Company have expressed their willingness to supply that municipality with light and power.

Toronto, Ont.—City Engineer Rust has requested the Board of Control to purchase two new 100 horse-power vertical motors for use at the filtration plant. These are to replace the 75 horse-power motors at present installed. The difference in the price is $1,900.

Verdun, Que.—The municipal ratepayers expressed themselves to be in accord with the proposed expenditure of $300,000 on works improvements, as specified in our issue of February 15th last.

GARBAGE, SEWAGE AND WATER.

Edmonds, B.C.—The municipal council have advised the controllers of South Vancouver that they will be in a position to supply 800,000 gallons of water to South Vancouver in event of a water famine in that centre.

Kingston, Ont.—The report of the yearly operation of the municipal water system has been prepared; the financial statement shows a surplus of $8,115.57. The revenue amounted to $43,377 and the expenditure $35,261.43. The expenditure on plant account included $3,376.61 for mains and services and $650.50 for water meters. The expenditure taken out of the rest fund included the sum of $3,747.48 for a suction pipe. The department had a surplus of $6,000 two years ago.

Montreal, Que.—One of the pumps in the Clark Street station of Montreal Water and Power Company broke down and caused the water supply to fail in the upper section of the city.

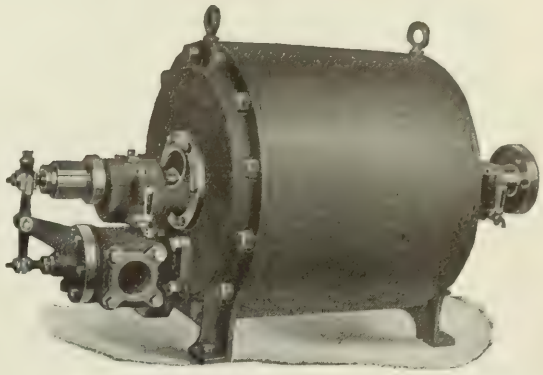
Regina, Sask.—Among the companies tendering on the construction of the large water tank for this municipality were John Inglis Co., Toronto; Chicago Bridge and Iron Works; Thos. Belair, Montreal; and the Des Moines Bridge and Iron Co., Des Moines, U.S.A. The tenders have been placed, by order of the council, in the hands of Walter J. Francis and Co., who will make a report.

Kerr Turbo-Generators

FOR SMALL LIGHTING PLANTS

The Kerr Turbine is peculiarly suited to generator driving and our sets are made in suitable sizes to fill all requirements up to 500 kw. alternating and 350 kw. direct current. The operation is economical throughout a wide range of initial steam pressures, the steam economy is improved by superheat, and any exhaust conditions are permissible. When operating non-condensing, the steam consumption compares favorably with that of a high speed engine of the same capacity, while in condensing plants the economy at full loads equals that of the best compound engine and at fractional loads is much better.

A Kerr Turbo-Generator for lighting or small power or both is extremely profitable in any plant having power boilers, since the freedom of the turbine exhaust from oil makes reuse of the exhaust inexpensive and safe for boiler feeding or any other purpose where clean low pressure steam is desirable. See Bulletin No. 22.



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Works, 512 WILLIAM ST., MONTREAL

THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO. LIMITED

48 in. CONTINUOUS STAVE LINE.

Manufacturer of

Galvanized Wire Machine Banded

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RESERVOIR TANKS

For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

Full particulars and estimates furnished.

PACIFIC COAST PIPE COMPANY, LTD.

Factory: 1551 Granville Street, VANCOUVER, B.C. P.O. Box 563.

St. Vital, Man.—Plans have been prepared by the municipal engineer, Mr. D. R. Baribault, calling for the expenditure of $500,000 on sewer and water system improvements. The plans call for the erection of a water purification plant to cost $200,000.

Toronto, Ont.—The municipal council are considering the following works expenditure:

New meters	$100,000
Two 36-inch mains under tracks, Main Pumping Station to Front Street	44,450
42-inch main along Front Street to Bathurst Street	55,048
24-inch main along Niagara Street to Queen Street	33,535
36-inch main cross town line, Beverley Street to Sumach Street	148,477

North Vancouver, B.C.—The municipal council intend to spend $137,000 on sewers and roadways.

BUILDINGS AND INDUSTRIAL WORKS.

Calgary, Alta.—A report states that the Sunlight Soap interests are considering the matter of establishing a factory in this city. Mr. Knight is the manager of the Toronto branch.

Calgary, Alta.—The management of the Canada Life Assurance Company are planning to erect a business structure at this point. The building is to be 75 x 80 of Gothic design and entirely fireproof. It is to be six stories in height. The head office of this company is in Toronto; Mr. J. W. Flavelle is the president.

Calgary, Alta.—Mr. E. Demiele is interested in the construction of a garage to cost $30,000. A permit has been secured for this work. The location is Eleventh Avenue between First and Second Street.

Fort William, Ont.—R. Vigars is having plans prepared for a 3-story apartment house to be erected on corner of Court and Van Norman Streets. Estimated cost, $25,000.

Levis, Que.—Representatives of the shipping interests have interviewed the federal government on the question of increasing the drydock facilities at this point. There are now fifteen ships on the St. Lawrence River too large for the drydocks now in use. Mr. Allen was the principal speaker of the delegation.

Lethbridge, Alta—The Rice Malting Company, Winnipeg, Man., are contemplating the erection of a plant at this point. Mr. P. H. Rice is the manager at Winnipeg

Moose Jaw, Sask.—A by-law calling for the expenditure of $6,000 for exhibition improvements, will be placed before the municipal ratepayers.

Moose Jaw, Sask.—The municipal council will submit a by-law to the ratepayers seeking authority to erect a $70,000 public library.

Saskatoon, Sask.—The plans for the hospital have been approved by the municipal council. The first portion to be constructed will be 160 x 48 feet, but the completed structure calls for a building 960 feet long and two wings 240 feet long, also a nurses' home and accommodation for fifteen hundred patients.

Saskatoon, Sask.—Mr. Allen Bowerman will erect a six-story building in this city. The new building will be of fireproof structure throughout. It is to have a frontage of 140 feet on 21st street and will run 75 feet south.

St. John, N.B.—The Canada Brush Company, Ltd., are erecting a new plant in this city. Machinery and raw material were ordered some time ago, and have been shipped from Germany, London and New York. It is intended to employ about seventy hands at the start, and it is expected that the company will be in full working order by May 1. Mr. John O'Regan of this city is interested in the project.

Toronto, Ont.—The Harbor Commissioners have instructed their engineer, Mr. Cousins, to prepare plans for the completion of the sea wall. When these are completed the board will confer with the municipal council with a view to have this work completed at an early date.

Toronto, Ont.—The congregation of St. Andrew's Church, King Street West, are about to erect a new parish building, to cost about $50,000. Mr. S. G. Curry, architect, is at present preparing the plans. The structure is to be completed by December 1st next.

Toronto, Ont.—The municipal council are considering the erection of the following fire halls:—

Greenwood Avenue Fire Hall	$30,000
Purchase price of site	7,004
Wychwood Fire Hall	30,000
Purchase price of site	7,004
Roncesvalles Avenue Fire Hall	25,000
Purchase price of site	7,000
Spare stable and supply in rear of the Adelaide Street Fire Hall	0,000

Victoria, B.C.—The Barbor Mattress Company, of Vancouver, are planning to erect a three-story frame factory on Topaz Street. The fire chief will be consulted in the matter.

Winnipeg, Man.—The municipal council has authorized the expenditure of $1,405,070 to extend the water supply. It is the intention of that body to obtain an additional supply from Poplar Springs and thus increase the available daily supply by 20,000,000 gallons.

Winnipeg, Man.—Messrs. Finnie and Murray have received a permit to erect an $85,000 warehouse in this city. Plans for six tall buildings have been placed in the hands of the building inspector for approval.

BRIDGES, ROADS AND PAVEMENTS.

Calgary, Alta.—Plans for several new bridges have been prepared by the city engineer, Mr. J. F. Childs. If these plans are approved by the council the cost will be $829,200. Several aldermen and councillers are reported to be in favor of using concrete for the materials of the above. If this is carried the cost will be about 40 per cent. above the estimate as quoted for steel structures.

Province of Manitoba.—The provincial legislature has set aside $100,000 per year, to be used for permanent highway construction and maintenance throughout the province.

Moose Jaw, Sask.—A by-law is to be submitted to the ratepayers of this municipality calling for the expenditure of $160,000 for pavement improvements.

Nelson, B.C.—This municipality is to have a $75,000 bridge across the Kootenay River, if the engineer now preparing a report gives a favorable reply. Provincial Premier McBride stated that it is to be a government project.

Toronto, Ont.—The municipal council are considering the erection of the following bridges:—

Crawford Street, reinforced concrete arch with girder span approaches	$ 29,450
Strachan Avenue, two steel plate girder spans, concrete floor, Class A, exclusive of land damages	58,200
Cattle market, steel lattice girder bridge on steel bench and steel approach ramps	14,900
Riverdale Foot Bridges, raising over span and adding two new spans over railway tracks	12,000
Gerrard Street Bridge, new bridge and river span—	
If of steel	151,800
If of concrete	200,000

FIRES.

Aylmer, Ont.—The pump works of Mr. Jas. Gillett were destroyed by fire on February 29th.

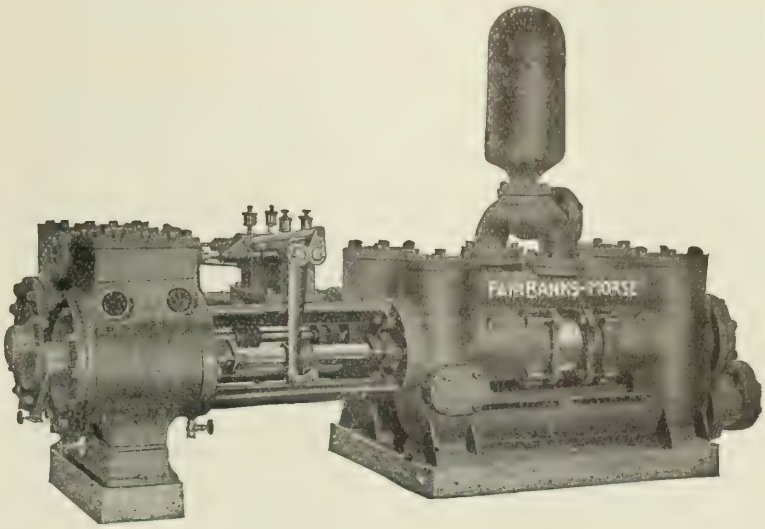
Chatham, Ont.—The elevator of the Canada Flour Mills Company was damaged by fire to the extent of $3,000.

Toronto, Ont.—The hide and fur establishment of Messrs. Hallam & Company was damaged by fire to the extent of $6,000.

CURRENT NEWS.

Province of British Columbia.—According to report the provincial government will spend $16,000,000 on improvements in that province during the next few months. The programme includes the construction of eight hundred and seventy miles of track.

Fort William, Ont.—The federal government are taking steps toward the leasing of two grain elevators at this point



PUMPS

The superior excellence and splendid results shown by

"FAIRBANKS-MORSE"

pumping machinery are largely due to the fact that for many years we have manufactured Hydraulic Machinery of all descriptions. We are therefore able to build pumps which are properly designed and adapted to every-day use. This is of the greatest importance in a first-class pump, for the usefulness of an engine may be lost if the pumping machine is badly designed.

You will get all these important features when you purchase a "FAIRBANKS-MORSE" pump.

Let us solve your pump problems.

THE CANADIAN FAIRBANKS-MORSE CO. Limited

Fairbanks Standard Scales — Fairbanks-Morse Gas Engines.
Safes and Vaults.

Montreal Toronto Winnipeg Vancouver Calgary St. John, N.B. Saskatoon Ottawa

They will be operated under the supervision of the grain board.

Montreal, P.Q.—The Richelieu and Ontario Navigation Company are about to try the experiment of burning oil on their steamers. The Rapids Prince and Rapids Queen on the Prescott-Montreal division will abandon the use of coal for the generation of steam. While the question of economy is largely problematical, it is expected by the Richelieu officials that the saving effected by a reduction of the crew necessary to look after the oil burning equipment will be considerable, while the absence of smoke and dirt should appeal to the passenger traveling on the line between here and Prescott.

Moose Jaw, Sask.—The City Commissioners are advertising for tenders for materials for extension of the electrical system. The tenders asked for include: Copper and iron wire, cedar poles, cross arms, pole line hardware and miscellaneous line supplies. J. J. Antonisen, city engineer.

Moose Jaw, Sask.—A committee has been formed to prepare a report on the question of erecting a new municipal hall. Ald. Caldwell has moved that competitive plans be called for the structure. The estimated cost is placed at $250,000.

New Westminster, B.C.—Ald. Dodd announced to the Trades and Labor Council that the municipal council have made $3 the daily wage for civic labor.

New Westminster, B.C.—A petition to submit a by-law to the ratepayers regarding the installation of a municipal gas plant has been presented to the civic council. A movement is being made to have a hospital by-law voted upon at the same time. Water and light extensions, fire and police apparatus, and the provision of storehouse and bunkers for the city, are some of the other requests to be made the subject of by-laws.

Ottawa, Ont.—The annual Dominion exhibition, to which the Federal government makes a grant of $50,000, will this year be held in Ottawa. The exhibition will probably last two weeks and will be the greatest ever held in Ottawa.

St. John, N.B.—Messrs. Norton-Griffiths, who have received the contract for the Grand Trunk Pacific terminal at this point, expect to have work under way by April 1st next. Mr. P. R. Warren will have charge of this work for the contractors.

Stettler, Alta.—The municipal Board of Trade have made a recommendation to the council that a large electric light be placed on the elevated water tower to serve as a landmark for travelers after dark. Mayor Bentley expressed himself to be in favor of the project.

Sydney, C.B., N.S.—The new sulphuric acid plant of the Dominion Iron and Steel Company is reported to be giving entire satisfaction. The erection of the new plant is under the personal supervision of F. J. Faulding, consulting engineer, of New York. This plant is a most important addition to the steel industry, and will employ a very large number of men.

Thorold, Ont.—This municipality voted in favor of granting certain privileges to the Thorold Township Paper Mill by a majority of 504.

Toronto, Ont.—The Harbor Board has issued instructions to tenants residing in certain houses along the water front of Ashbridge's Bay to the effect that they must vacate. The board consider the location unhealthy for human habitation.

Victoria, B.C.—Dr. Young, Provincial Minister of Education, Province of British Columbia, is now inviting plans for the first buildings to be erected on the Point Grey university site, at a cost of $1,500,000, and the competition is limited to Canadian architects. Ten thousand dollars will be given in awards.

Western Canada.—The railways report that there will be need of sixty thousand laboring men in this portion of Canada during the coming season.

State of Kansas, U.S.A.—A report states that the engineering department of the state university will in future investigate all companies attempting to sell stock for the development of any new invention. The banking department of the state will pass on the business end of the new companies and the merits of the mehcanical inventions will be tested by the engineering department of the university.

TRADE INQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ended February 12th, 1912. Fuller information may be obtained by communicating with the Department of Trade and Commerce, Ottawa.

A London firm are anxious to get in touch with Canadian manufacturers of machinery for making wood pulp.

A South of England firm of paint, enamel and varnish manufacturers desire to introduce their goods into the Canadian market.

A firm in the English Midlands manufacturing ebonite sheets, rods and tubes, fibre sheets, rods and tubes, rubber washers, buffers, mats, sheeting, valves, bath plugs, caster bowls, and solid tyres for motor vehicles, are desirous of appointing Canadian agents.

A Welsh firm of slate manufacturers desire to get into touch with a Canadian firm in a position to store their slates and sell on commission.

A correspondent in Roumania stated to have good connections among agriculturists is open to take up the agency of Canadian manufacturers of ploughs and other agricultural machinery, electro-technical machinery, etc. Correspondence in French.

A London firm ask to be placed in touch with influential Canadian firms who are importers of Burmese buffalo hides, dry and wet salted.

A London company manufacturing electrical motor and generators, lamps, switch gear and appliances, and equipment generally, are looking for suitable Canadian resident agents.

A London firm ask for the addresses of Canadian manufacturers of beef powder.

A firm of brokers, import and export, in British Columbia, are desirous of securing a high-class agency. Canadian bankers' and London references.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16009—February 20—Authorizing C.P.R. to take land for enlargement of Windsor Street Passenger Terminals at Montreal,, Que.

16010—February 22—Authorizing C.P.R. to open for carriage of traffic diversion of its railway in Dist. of Thunder Bay, from mileage 92.24 to 93.42, and 93.92 to 95.12, and rescinding Order No. 15932 of February 12, 1912, (old main line revision).

16011—February 23—16012—February 19—Authorizing C.P.R. to use and operate bridge No. 27.3 on MacLeod S.D. and No.'s 11.9 and 24.4 on Souris Subdivision.

16013—February 19—Authorizing C.P.R. to construct spur for Messrs. Britnell & Co., Ltd., at Cooksville, Ontario, mileage 14.75 on London S.D.

16014—February 20—Authorizing C.N.R. to construct across 5 highways on its Prince Albert-Battleford Line.

16015—January 23—Authorizing Nakusp and Slocan Ry. (C.P.R.) to construct branch line or spur into Truro Mineral Claim unsurveyed, for a distance of 6 miles.

16016—February 23—Extending for 60 days from date of this Order time for installation of interlocking plant by Essex Terminal Ry. in city of Windsor, Ont., crossing to be used for construction purposes during extended period.

16017—February 20—Approving Klondike Mines Rly. Co.'s Standard Freight Mileage Tariff for Carload Traffic, C.R.C., No. 5.

16018—February 20—Directing G.T.R. to file plans within two months from date of this Order for bridge where its railway crosses the Perche Drain, Twp. of Sarnia, Ontario.

16019—February 22—Directing that plan approved by Order 7,200 and filed with Board April 27th, 1909, be amended by showing York Street opened to Lake Street, and that subway full width of street be provided through elevated portion of railway lines and tracks. Question of Compensation for land damages, etc., to be reserved. Toronto Grade Separation, G.T.R. and C.P.R. Railways.

16020—February 24—Authorizing James Bay and Eastern (C.N.R.) to cross public road on Lot 19, between Rges 1 and 2, Twp. of Dufferin and County of Lake St. John, Quebec.

16021—January 30—Authorizing C.P.R. (G.B. & S. Ry.) to use and operate bridge across public road at mileage 56.4 Ct. Victoria, Ontario.

16022—February 23—Approving Standard Tariffs of Maximum Freight and Passenger Tolls C.R.C. no. 102 of Napierville Jct. Ry.

16023—February 17—Authorizing G.T.P.B.L. Co. to construct spur for Prince Albert Lumber Company's Mills, Prince Albert, Sask.

16024—February 22—Certificate of correction to G.T.B.B.L. Co. re error in location plan Yorkton-Canora Branch.

(Continued on pages 72 and 74.)

Volume 22. Toronto, March 14, 1912

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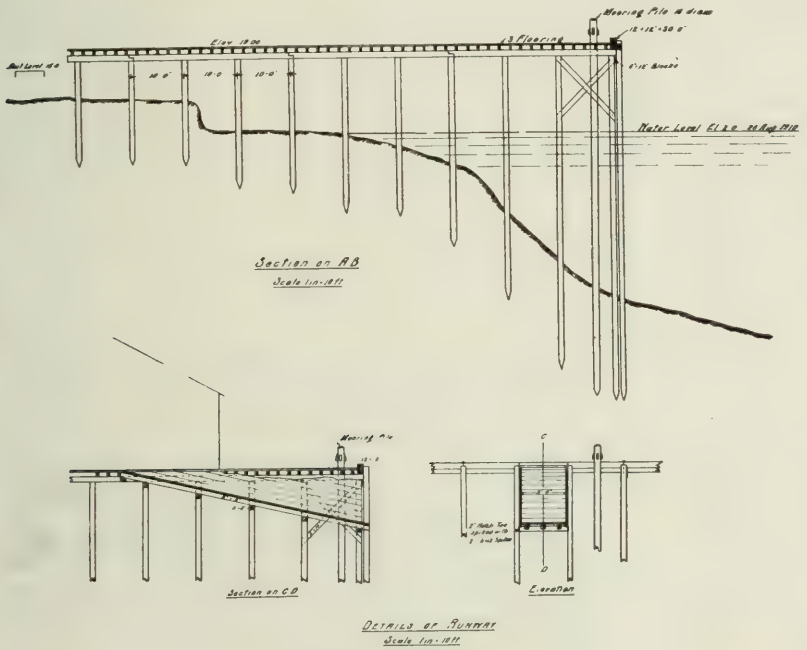
The Canadian Engineer

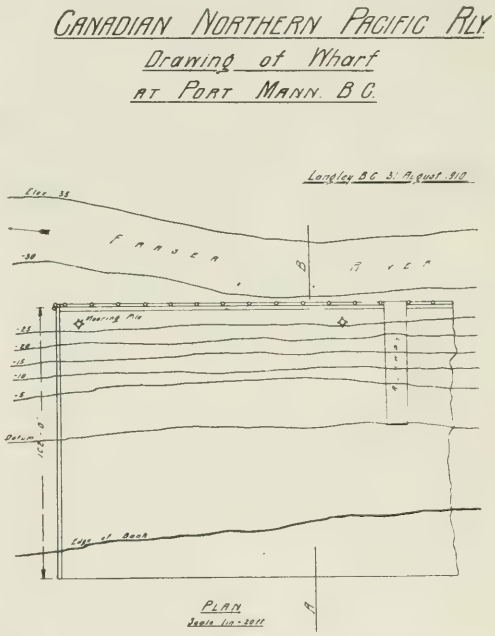
An Engineering Weekly

CANADIAN NORTHERN PACIFIC RAILWAY COMPANY'S WHARF AT PORT MANN, B.C.

BY W. C. SWAN, C.E.

The Fraser River is by far the greatest highway for fresh water shipping in British Columbia. It is navigable at low water for a distance of 60 miles from its mouth, while at high water it is navigable as far up as the town of Yale, more than 100 miles from the mouth. The river is tidal for 55 miles, at which point very slight rapids, known as the Sumas Riffle, overcome the effect of the tide. The current flows at the rate of seven miles per hour through the Riffle. The average rate of flow on the lower 50 miles of the river is about three miles per hour during the greater part of the year, and five miles per hour during the freshet time of June and July.





The finest agricultural land of British Columbia is, undoubtedly, to be found in the Lower Fraser Valley. The low lying portions, subject to flood at high water, are gradually being reclaimed by the construction of privately owned and government dykes. The corrosion of the bank is, however, the greatest difficulty to be overcome in preserving this splendid soil. Hundreds of acres are washed away annually, and the writer knows of one farm which has, during the past ten years, lost forty acres of first-class farm land. It would require, at the lowest estimate, $40,000,000 to adequately protect the banks of the Lower Fraser Valley, and to properly confine the river to its present channel.

Situated 20 miles from the mouth of the river is the townsite of Port Mann, the future industrial terminus of the Canadian Northern Railway on the Pacific Coast. Seven hundred and fifty acres, or about a third part of the townsite, have already been cleared. The accompanying photograph will give some idea of the natural features of the townsite. The location has been pronounced by prominent landscape artists and engineers to be an ideal one, as it undoubtedly is. Running back from the river, it is level for about half a mile, then there is a fairly abrupt rise of about seventy-five feet, beyond which a uniform slope of two or three feet per hundred is maintained clear to the boundary of the townsite. The area is broken only by three small streams.

Situated on the waterfront, slightly east of the central portion of the townsite, lie the Port Mann yards, where several miles of track have already been laid. Port Mann wharf stands on the Fraser River opposite the middle point of the yards. The object of this article is a description of Port Mann wharf.

The pardon of the reader is requested for so lengthy an introduction, but in view of the comparatively recent development of British Columbia, it has seemed to the writer that this geographical description might not be amiss.

Before locating Port Mann wharf, two and a half miles of water frontage were carefully sounded, lines of sounding being extended from the shore at short intervals, for 150 ft. into the river. The location selected gives the best water

available, for although a depth of 30 ft. of water was obtained 100 ft. from shore for practically the whole two and a half miles of water frontage, 45 ft. is found 100 ft. out from the shore for the entire length of the wharf, and for severol hundred feet farther west. The accompanying cross section of the wharf gives an accurate idea of the river bed at the point in question.

The sounding rods were then used to determine the nature of the foundation for piling. It was with great difficulty that the rods were put down, and with still greater difficulty that they were withdrawn. The soil is a river silt for a depth of at least thirty feet. This silt is a very

View of Port Mann Townsite, Looking South.—Taken from the Wharf.

fine sand, sticky like quicksand, when wet, but much firmer. Before making out a bill of piling, it was thought advisable to drive test piles. Two test piles were accordingly driven. The first was given a 25-ft. penetration, going at the last blow under a six-foot drop of a 4,300-lb. hammer, a distance of 15 inches. The second pile was given a penetration of 35 ft., going at the last blow 6 inches under a 10-ft. drop. Both piles were allowed to stand over night. Next morning the shorter pile penetrated only 3 inches under a 10-ft. drop of the hammer, while the longer pile resisted driving for seven blows under a 10-ft. drop of the hammer, and finally, being started, went 4 inches at a blow. It was accordingly decided that 30 to 35 feet of penetration was sufficient. It was found later that 35 ft. of penetration best suited the inner half of the wharf, while 20 to 25 feet was ample for the outer piles.

The distance between piles was, of course, governed by the loading of the wharf and the bearing power of the piles. When an impenetratable stratum of material is met with the pile probably derives its bearing power to the greater extent from this end bearing, but where penetrable soils are encountered throughout the driven length of the pile, the bearing is derived almost entirely from frictional resistance on the surface of the pile. The maximum bearing power of any pile is, of course, fixed by the strength of the projecting portion of the pile as a column.

To determine the bearing power of piles from calculation the Engineering News formula is the most simple and quite as reliable as any.

$$P = \frac{2\,w\,h}{d - 1}$$

where P is the safe bearing load in tons
W is the weight of the hammer in tons.
h is the fall of the hammer in feet, last blow.
and d is the penetration in inches, last blow.
Another simple formula is given by Saunders.

$$P = \frac{w\,h}{8\,d}$$

the notation being the same as above with the exception that "d" is the penetration in feet. Both are empirical formulae, and must, of course, be used with judgment. I consider that either of these formulae is very reliable and convenient. The following is a comparison of values given for "P" for the same pile.

W = 1.5 tons.
h = 10 ft.
d = 2½ inches = 0.21 ft.

Engineering News formula—

$$P = \frac{2 \times 1.5 \times 10}{2.5 - 1} = \frac{2 \times 1.5 \times 10}{3.5} = 8.6 \text{ tons.}$$

Saunders' formula—

$$P = \frac{1.5 \times 10}{8 \times .21} = \frac{1.5 \times 10}{1.68} = 8.9 \text{ tons.}$$

This is, indeed, a very good comparison, having less than 4 per cent. variation.

Before giving the details of construction of Port Mann wharf, it may be well to note the dimensions, which are as follows: Floor length, 1,000 ft.; floor width, 102 ft. The floor of the wharf is 16 ft. above mean water level of the Fraser River at this point. A bill of material covering all the materials of construction is given at the close of this article. The east 500-ft. section is known as the rail unloading wharf, and the west 500-ft. section as the freight wharf, over which it is proposed to construct freight sheds 76 ft. by 490 ft.

Let us now look at the details of construction of the wharf. First, to consider the foundations; cedar piles were used entirely for bearing. Under the rail unloading wharf the piles were spaced at 9 ft. centres, the bearing load per pile being 16 tons (of 2,000 lbs. each). This was equivalent to the dead load of 400 lbs. per sq. ft., corresponding to eight single tiers of 80 lb. steel rails piled as closely as possible. As a matter of fact, portions of the rail unloading wharf have had occasion to carry the weight of six double tiers of rails, or twelve single tiers, and not the slightest settlement was noted. The freight wharf piles were spaced at 10 ft. centres, the designed load being 300 lbs. per sq. ft.,

Rear View of Port Mann Wharf and Yards Under Construction.

which gave a total bearing of approximately 15 tons per pile. In every case where the driven piles were allowed to stand over night, and the hammer put on the next morning, they resisted driving entirely for several blows, so that a bearing load of 15 or 20 tons per pile gave an entirely ample factor of safety. The piles used were a splendid quality of cedar, such as are only to be found in British Columbia, being straight, sound and maintaining well their size. The longest of these was 90 feet. Springing piles at the face and end

of the wharf were of fir, as were also protection clusters driven at the wharf ends and the mooring piles, since, in a matter of cross bending fir has nearly three times the strength of cedar.

Next, let us consider the timber in the wharf. Douglas fir was used entirely, being the cheapest, and also the best, timber in British Columbia. This timber retails at from $13 to $15 per M., according to the sizes. It was supplied by the Canadian Western Lumber Co., whose immense mills on the north bank of the Fraser River, almost directly opposite Port Mann, are probably the largest in the world. The caps are 14-in. by 14-in. timber, a section of which, although not the most economical for the given loading, was considered best, as it gave added stiffness to the bents and provided a better joint. The caps were run at right angles to the face of the wharf. The splice indicated on the accompanying elevation was a 12-in. step joint, which, with the head of the pile having a minimum diameter of 18 in., provided for at least a 3-in. bearing of the cap outside the splice. To obtain this 3-in. bearing, however, occasioned some difficulty with the contractor, so that a butt joint was substituted, the ends of the caps being fastened down with a 24-in. drift bolt, driven 4½ inches from the end of the cap. The position of the shorter cap, as shown on the elevation, was varied, so that the break in the cap joints of alternate bents did not fall opposite to one another.

The joists were of dimensions 4 in. by 10 in., being staggered and overlapping one foot. They were toe-spiked to the cap with 6 in. wire spikes. The flooring was 3 in. in thickness. It should have been specified as dressed to 3 in. thickness, but this was not done, and in consequence the first portion of the floor laid was somewhat rough. The wharf floor was faced with two pieces of 12 in. by 12 in. waling drift bolted to one another, as shown in the elevation, and drifted in turn to the caps. This waling was perfectly lined, and has given the face of the wharf a very finished appearance, and has also done good service in operating the wharf to date.

Outside of each of the outer bearing piles were driven springing piles of fir. These springing piles were driven rather farther from the bearing piles than is shown on the plan, being distant 3 ft. centres at the river bed, and butted against the 14-in. by 14-in. cap with twelve inches clear be-

Fraser River, from C.N.P. Railway Track.

tween the piles at the top. Their object is, of course, to take the shock of a vessel coming to her mooring alongside the wharf. These springing piles were cut off on a bevel, being flush with the upper 12-in. by 12-in. wale on the inside, and sloping outward at an inclination of 30 to the horizontal. This uniformity of slope of these outer piles considerably enhances the appearance of the wharf. An 8-in. by 12-in. spacing wale was made fast along the entire face of the wharf, between these springing piles.

Mooring piles were driven as shown on the plan. They were braced to the four nearest bearing piles by means of 8-in. by 8-in. struts.

On the freight wharf two runways were constructed according to the details shown on the plan. Sliding stringers support the removal planks of the flooring over the runway, so that when not in use the runways may be covered in. These sliding stringers operate on rollers suspended from the joists of the adjoining portion of the wharf. They may be handled by one man quite readily.

Three four-pile clusters were driven at each end of the wharf, the first at the outside corners as a protection to that portion of the structure, and the two inner clusters in a line,

Port Mann Wharf, from the River.

making an angle of 45 with the face of the wharf. These clusters support glance booms, which were placed at the wharf ends to fend off ice in winter, and floating trees, &c., at freshet time. Owing to the tide causing a change in the direction of the current during the winter season, the placing of a glance boom at the west end of the wharf was also necessitated. The cluster piles were bound together near the top with ¾-inch steel cable.

Below is given the bill of material for the entire wharf.

CANADIAN NORTHERN PACIFIC RAILWAY.
Bill of Material, Port Mann Wharf.
Piling.

Bearing Piles 12 in. up—					
226	piles,	45 ft.	long	10170	lin. ft.
484	"	55 "		26620	" "
122	"	60 "		7320	" "
77	"	65 "		5005	" "
90	"	70 "		6300	" "
60	"	75 "		4500	" "
102	"	80 "		8160	" "
59	"	85 "		5015	" "
17	"	90 "		1530	" "
1237				74620	lin. ft.
Springing Piles 12 in. up—					
8	piles,	35 ft.	long	280	lin. ft.
1	"	45 "		45	" "
1	"	55 "		55	" "
10	"	60 "		600	" "
79	"	65 "		5135	" "
26	"	70 "		1820	" "
125				7935	lin. ft.
				82555	lin. ft.
Mooring Piles 18 in.—					
4	piles,	60 ft.	long	240	lin. ft.
2	"	75 "		150	" "
5	"	85 "		425	" "
11				815	lin. ft.
				83370	lin. ft.

Deck and Flooring.

Caps 14 in. by 14 in.—
153 pieces, 32 ft. long.....79968 F.B.M.
168 " 28 " .....76830 "
56 " 22 " .....20123 "
51 " 12 " ..... 9996 "
186917 F.B.M.

Stringers 4 in. by 10 in.—
816 pieces, 32 ft. long.....87040 F.B.M.
918 " 28 " 85680
51 " 26 " 4420
51 " 12 " 2040
179180 F.B.M.

Flooring 3 in..... 302000 F.B.M.
Wales—Upper and lower—
74 pieces, 12" x 12" x 30' 0" 26640 F.B.M.
Bracing 3 in. x 10 in. x 16 ft. 0 in.—
214 pieces ..... 8560 F.B.M.
Struts (Between Springing Piles) 8 in. by 12 in.—
48 pieces, 9 ft. long..... 3456 F.B.M.
56 " 8 " ..... 3584 "
7040 F.B.M.
Blocks (Between Springing and First Row Piles—
107 pieces, 6 in. x 12 in..... 642 F.B.M.
Cleats for Mooring Piles—
50 ft. 3 in x 5 in..... 62 F.B.M.

Iron.

107 machine bolts ¾" x 45", threaded 3" (Wrought iron)
208 machine bolts, ¾" x 27", threaded 3" (Wrought iron)
428 machine bolts, ¾" x 24", threaded 3" (Wrought iron)
337 machine bolts, ¾" x 17½" (Wrought iron)
1367 drift bolts, ¾" x 24" (Wrought iron)
2200 O. G. washers, ¾" x 3½" (Cast iron.)
120 kegs (100 lbs. each) 6" wire spikes.

RUNWAYS (TWO).

12 Cross pieces, 8" x 8" x 9' 4"..... 600 F.B.M.
6 Stringers, 8" x 8" x 26' 0"..... 832 F.B.M.
6 Stringers, 8" x 8" x 24' 0"..... 768 F.B.M.
Flooring, 3" .....2448 F.B.M.
Side sheathing, 3" x 12" x 418' 0" (x 2).....2520 F.B.M.
30 Sliding stringers, 5" x 10" x 12' 0".....1500 F.B.M.
2 Guards, 3" x 10" x 10' 0"..... 60 F.B.M.

Iron.

120 W. I. Spikes, ½" x 12".
1 Keg (100 lbs. to keg) 6" wire spikes.

In closing it will be of interest to note the cost of this work. The piling was paid for under two headings, "Piles driven in the finished work" and "Pile cut-offs," the price for the latter being the cost of the pile delivered on the work. Summing the daily records of time and material, the approximate cost of the various portions of the wharf was as follows:—

Piles driven in finished work ..... $ 0.18 per lin. ft.
Pile cut-off ..... 0.10 per lin. ft.
Timber ..... 17.50 per M.
Iron (wrought and cast) ..... 0.0475 per lb.

Considering the high price paid for labor covering this work, the cost is very reasonable indeed, as wages for labor generally in British Columbia are 40 per cent. higher than those paid in Ontario at the present time; and it might be well to add, so is the cost of living. Why? Because we have in this province, generally speaking, the laziest farmer in Canada, living on the unearned increment. But that is another story.

Some minor changes were necessitated from time to time in the bill of material, but as the final estimate varied less than 2 per cent from the foregoing bill of material, these changes are not worth recording.

PEEL COUNTY ROADS.*

C. R. Wheelock, County Engineer.

The system of roads assumed by the county of Peel, and approved by the Lieutenant Governor-in-Council, as provided by the Highway Improvement Act, is said to be one of the best laid out systems in the province. The county is an irregular shape, the townships adjoining the easterly and northerly boundaries being gores. It increases from a width of eight miles at the southerly boundary (the northerly shore of Lake Ontario) to a width of 19 miles at the north and the greatest length from south to north is 35 miles. The road system consists of one main north and south road, known as Hurontario Street, running through the county from Port Credit on the lake shore at the south to Orangeville at the extreme north, and the following main roads running east and west, all of which cross Hurontario Street; the Lake Shore Road, running along the lake shore through the county; Dundas Street from the Etobicoke River (the easterly boundary of the county) to Erindale; the Brampton Side Road, from the ninth line of Toronto Gore Township (near the easterly boundary of the county) to the westerly boundary of the county; the Bolton and Terra Cotta Road, from Bolton to the westerly boundary of the county. Besides the above main roads, there are a number of shorter pieces, all connected with the main roads except ten miles in the north part of the township of Albion, leading to the village of Palgrave. This makes a well connected system of roads leading to the markets of the county, and also forming connections with main roads in adjoining counties for through traffic.

The by-law designating a system of roads to be assumed by the county was passed by the council in 1906, and work was commenced on the roads in the following year. The principal work done the first year was the building of a number of bridges and culverts necessary to allow the heavy road-building machinery to pass over the roads, only one mile of road was completed. This piece of road was well constructed. In the first place, it was properly graded and drained and then metalled with crushed stone consolidated with a steam roller. Although there was considerable opposition from the people while the work was being done, after it was completed everyone seemed to be well satisfied, and the work on the county roads has gone on steadily since that time with very little opposition. At the end of last season 65 miles had been graded, metalled and completed, and besides about 10 miles were graded ready for metal. Permanent bridges and culverts, of cement concrete and steel, have been built where required on almost the whole system, leaving very few old ones to be replaced. We have built a total of 41 bridges of 10-feet span and over, and 58 reinforced concrete culverts up to 10-feet span, and besides have put in 357 concrete and steel pipe culverts. The total amount expended up to the 15th of November last and certified as coming under the provisions of the Highway Improvement Act is $240,618.77, and the total amount paid to the county by the government, as provided by the Act, is $81,995.94 (including the one-third due for last season's work).

* Paper read at Ontario Good Roads Association Convention, Feb. 27th, 1912.

The roads are graded from 22 ft. to 28 ft. wide and metalled from 8 feet to 15 feet wide. The depth of the metal consolidated is from 6 inches to 7 inches. The metal used was crushed stone, crushed and screened gravel and natural pit gravel. The most of the crushed stone used was brought in by rail, as local material was not available, and in such cases the freight rates increased the cost very materially. In some cases the freight on stone which cost 50 cents per ton f.o.b. at the quarries was $1.00 per ton. If this association would take this matter up and could succeed in having the freight rates on stone reduced, it would certainly help along the good work of road improvement in sections where local material cannot be procured.

The total cost per mile for the different classes of roads was as follows:—

Roads metalled with crushed stone, shipped in, from	$2,500 to	$4,000
Roads metalled with crushed stone, local, from	2,000 to	2,500
Roads metalled with gravel crushed and screened from	1,800 to	2,300
Roads metalled with screened gravel	1,500 to	1,700
Roads metalled with pit gravel, from	900 to	1,300

The road machinery owned by the county is as follows: 3 ten-ton steam rollers which cost $8,300; 3 road sprinklers, cost $734; 2 rock-crushing plants, consisting of a crusher, elevator, rotary screen and 20-ton mounted bins, cost $1,400 for each plant; 1 gravel-screening plant, consisting of a 4 horse-power gasoline engine, elevator, rotary screen and 12-ton mounted bins, cost $1,125; together with graders, wheel scrapers, drag scrapers, plows and tools; amounting in all for the entire plant to about $14,500.

The cost of operating a plant crushing stone amounted to $15 per day, including the amount paid per day for a 14 horse-power traction engine which supplied the power. The amount of stone crushed averaged about 40 cubic yards per day, making the cost of crushing about 37½ cents per cubic yard.

The crushing plants were also used in gravel pits where there was an excess of coarse gravel and stone. The material was run through the crusher, screened and separated in the bins. The cost of operating, including the cost of handling stone and gravel in the pit, was about $25 per day. An average of about 60 cubic yards of metal per day was turned out, making the cost about 42 cents per cubic yard.

The gravel-screening plant was used in a pit where there was an excessive amount of sand intermixed with the gravel. This was screened out and the fine and coarse gravel which was left was separated in the bins ready for the roads. The cost of operating was about $10 per day, and the amount of screened gravel obtained about 28 cubic yards per day, making the cost of screening about 36 cents per cubic yard.

The Highway Improvement Act has done much to demonstrate to the people of Ontario the advantage of good roads, and has given an impetus to road building on scientific principles in many parts of the province. It has, however, been generally admitted that for obvious reasons the aid given to counties under the Act is not sufficient for main roads which have to be kept up for through traffic. And it now seems that in the orderly course of progression the time is ripe for a further step in the shape of a provincial system of highways, to be built and maintained by the province, with the aid of the subsidy to be given by the Federal Government for the improvement of highways. These roads would be object lessons in the scientific construction and maintenace of highways, and would do much for the cause of good roads in an educational way. Besides, the best results should be achieved at a minimum cost, as the roads could be constructed and maintained on the most approved principles under experienced supervision.

In selecting the roads for a provincial system of highways the object in view should be the greatest benefit to the greatest number, and in carrying out this very wise maxim the farmers, who are the backbone of this agricultural province of ours, should get the first consideration. In fact, it seems to me that if we do what is in the best interests of the farmer in this matter, we will not require to go much further, as the interests of the farmer are so interwoven with the interests of the business man and the prosperity of the urban municipality depends so much on the prosperity of the rural municipality, that their interests cannot be separated.

Now, I do not think any general scheme can be laid down for this system of roads in old Ontario that is more practicable and will answer all purposes better than a connected interurban system having at least one main road through each county. This would provide a system of trunk roads for tourist traffic, as well as the roads for interurban traffic. This system of roads built and maintained by the province, with well constructed lateral roads or feeders built by the counties, would give us a system second to none on the continent. It would require, say 2,200 miles of road, to cover this system and would cost, say $15,000,000. This amount would necessarily be spread over a number of years, as it would be required only as the roads were built, and would be a small amount compared with the enormous sums expended on roads by other progressive counties.

BUILDING STONE FROM BLAST FURNACE SLAG.

The manufacture of building stone from smelter and blast furnace slag is an industry of considerable importance in Germany, and is carried on to a greater or lesser extent at nearly all these furnaces. The process is not patented and is very simple in details. Practically all blast-furnace and smelter slag is suitable for stone-making. Slag for this purpose must, however, be in a granulated state. After it has been allowed to harden it is unsuitable. All attempts to utilize slag that has been crushed or ground, after having once hardened, have failed to produce solid stone.

The slag is granulated by the addition of water as it flows hot from oven or furnace. The granulated slag after being thoroughly mixed with the required proportion of lime is allowed to stand one hour before being put through the press. After being pressed, the stones are stacked in the open air, where, after three or four weeks, according to the weather, they are ready for use. Under low temperature they harden slowly. If subjected to frost before thoroughly hardened, they are crumbled and destroyed. Operations may, however, be continued in the winter, the stones being hardened in steam-heated drying rooms. These stones grow constantly harder with time and after several years show a resistance of 100 kilos. per square centimetre.

THE BRITISH COLUMBIA ELECTRIC RAILWAY.

The report of this company up to the 30th of June, 1911, has been published in London, England. The net profits for the year are shown by this statement to be $1,363,461.00; this is an increase of 17% over the net earnings of the preceding year. The company now have 233.65 miles of track and 647 cars in operation. The number of passengers carried during the year was 46,541,448. The report shows that the company are planning for considerable development work in the near future.

TESTS ON THE STRENGTH OF NAILED JOINTS.*

J. H. Thornley, B.A.,Sc., '08.

In this day of steel and concrete, a discussion of anything pertaining to timber construction may seem somewhat out of place, but to the Canadian hydraulic engineer at least timber is still a building material of prime importance.

The brief nail test here reported was made in connection with the design of the Porcupine Power Company's Hydro-Electric plant at Sandy Falls on the Mettagami River, built by H. D. Symmes, of Niagara Falls, Ontario.

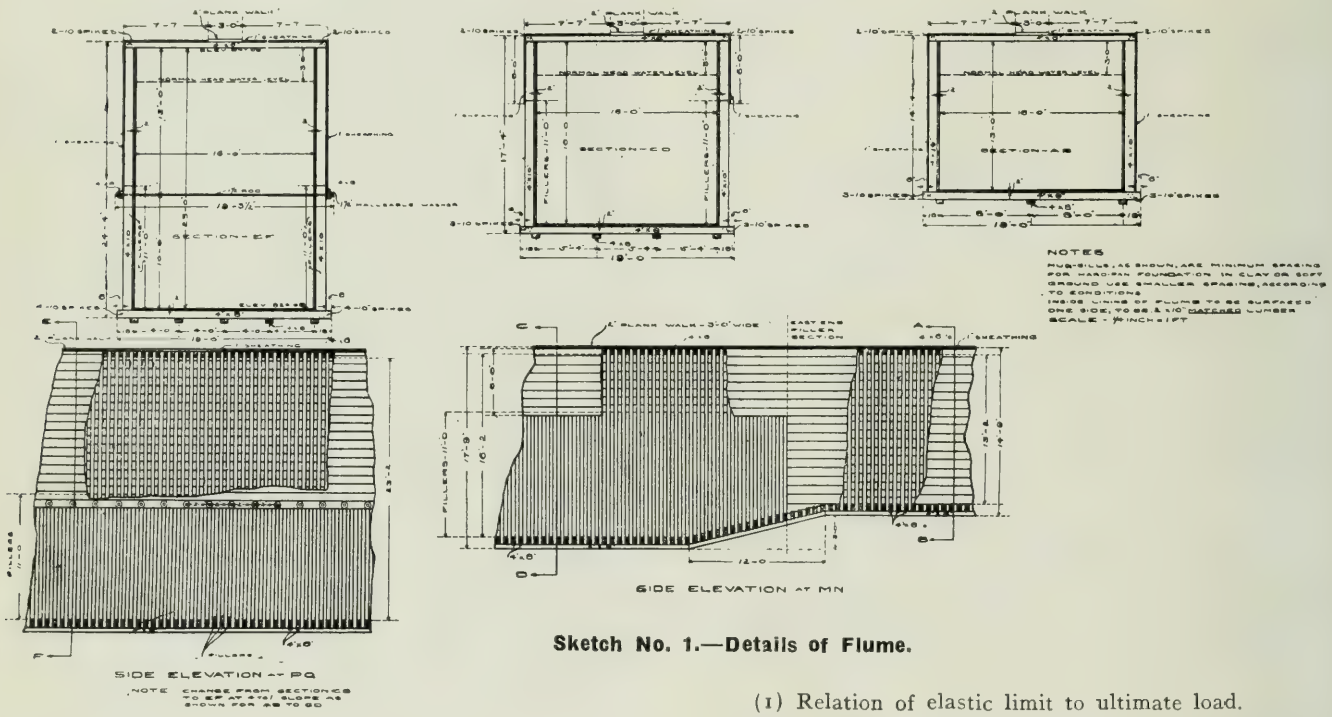
A word or two regarding this plant may be in place since the qualities sought in the joints tested can only be understood by a consideration of the special construction conditions.

Since the generating plant, a 4,500 h.p. hydro-electric station, was at the time of construction more than forty miles by bush road from the nearest station, and since it was essential that the plant should be constructed with the utmost speed, it was desired to cut to a minimum the use of steel, concrete or other bulky materials requiring to be brought in from the railroad. It was, moreover, desirable to use none but the simplest timber construction on account of the difficulty of turning out carefully sized lumber from a temporary sawmill, and also because it was the intention to avoid labor trouble by using lumberjacks rather than carpenters for the bulk of the work,—an obvious impossibility on work demanding car ful framing.

A rock filled corn crib and stop log dam and timber power house would satisfy conditions both in the matter of construction and material, but the flume offered difficulties. The standard types demanded a great deal of steel in the form of bolts and tie rods and the use of these bolts and rods demanded a fair average degree of skill, in the gangs erecting the work. Finally, after getting out several designs, that shown in Fig. No. 2 was suggested. As will be noted, the construction consists of a corn crib, such as is used in a crib and stop log dam, only that in the case of the flume the crib is turned on its side and sheeted on the inside instead of the outside. This construction called for the use of a minimum of steel, and since practically no skill was needed beyond the ability to drive nails, the flume could be built by lumberjacks quite as well as by carpenters. The one question in doubt was that of the possibility of constructing a nailed joint sufficiently strong to withstand the hydrostatic pressure. It was to determine this point that the tests, the results of which follow, were run.

Purpose of Test.—To ascertain the transverse holding power in pine lumber of nine-inch spikes (4½ to the pound), and in particular to find the permissible load on a nailed joint as used at lower corner of a corn crib flume of construction as shown in Sketch No. 1, and to find what nailing will give maximum strength for such a joint, that is, to find a nailing with which failure will be equally likely to occur by cracking of the timbers or by drawing of the nails.

Three characteristics of any timber joint of great importance are:



Sketch No. 1.—Details of Flume.

(1) Relation of elastic limit to ultimate load.

(2) Extreme permanent deflection possible without lessening of ultimate strength. This point is of prime importance since, owing to the inequalities in size of commercial lumber, more particularly in unplaned material and to unavoidable inaccuracies in work fabricated by carpenters, joints are often called upon to undergo very considerable deflections before the theoretical distribution of loads occurs.

(3) Effect of moisture and frost. The present test would have no bearing upon this point.

Method of Test.—The specimen was made by nailing together three pieces of 4 in. x 8 in., 4 in. x 10 in., 3½ in. x 8 in., or various combinations of these sizes, as shown in Sketch No. 3.

Sketch No. 2 shows the nailing used for the most of the tests.

Sketch No. 1 shows the nailed joint as used in the flume.

In Sketch No. 3—

"A" is a ½-in. steel plate used to distribute the load applied to the end of the 4 in. x 8 in. piece marked "F."

"B" is a universal head of the ball and socket type.

"G" and "H" are piles of blocking.

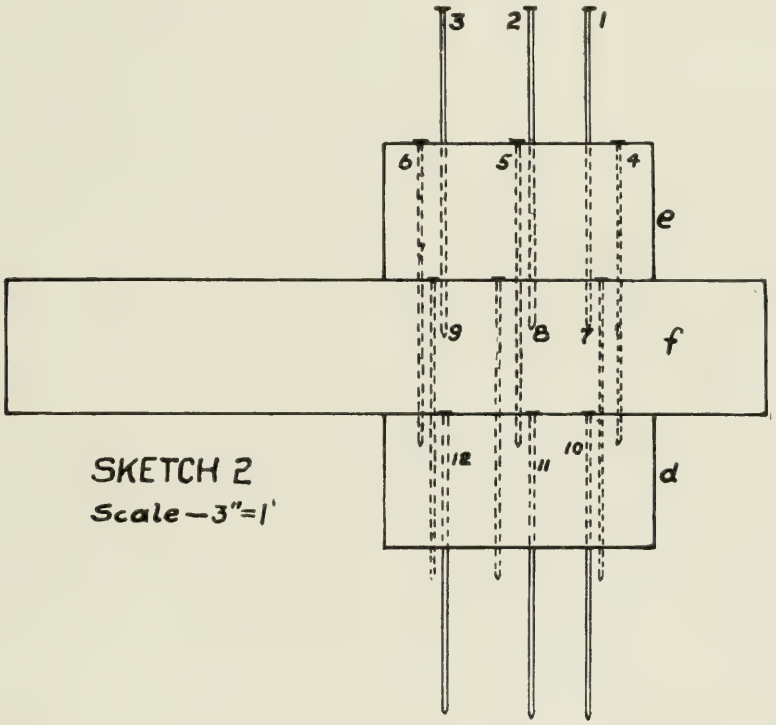
* From Applied Science, Feb., 1912.

"C" is a wedge-shaped piece of steel attached to the upper or movable head of a one hundred ton testing machine.

In several of the experiments the universal head "B" was dispensed with and the load applied directly to the steel plate "A." This had no apparent effect on the results.

Analysis of Nailing in Accordance with the General Laws, as Deduced from Previous Experiments.—Referring here to Sketch No. 2, which represents a joint at the lower corner of a 13 ft. x 16 ft. section of the flume, the effect of nails Nos. 1, 2, and 3 on the elastic limit load of the joint is obtained thus:

Since "grip" has no effect on elastic limit of joint, the elastic limit load of nail No. 1 should be $Cd^2 = 5500 \times (\frac{3}{8})^2 = 770$ pounds. The effect on the ultimate load of the joint



will be $2\,Cd^2 \times \frac{\text{grip}}{\frac{1}{3}\text{ length of nail}} = 2 \times 5{,}500 \times 9/64 \times \frac{1}{3}$

= 518 per nail if failure result from drawing of the nails.

The effect of nails Nos. 4, 5, and 6 on the elastic limit of joint must be considered for the points "A" and "B." Each nail will be effective at these points. Elastic limit load on No. 4 = $Cd^2 \times 2 = 5500 \times (\frac{3}{8})^2 \times 2 = 1540$ pounds. The ultimate load of No. 4 at "A" will be 1540 pounds and at "B" 513 pounds.

Each of Nos. 7, 8, and 9, will effect the elastic limit load to the extent of 770 pounds and the ultimate load to 1540 pounds.

Nails Nos. 10, 11 and 12 will have no effect on either the elastic limit or the ultimate load of the joint, except as they may effect a possible failure by cracking of the timbers.

Theoretical Elastic Limit Load of Joint as Shown.

From No. 1, No. 2, No. 3	2310
From No. 4, No. 5, No. 6	4620
From No. 7, No. 8, No. 9	2310
From No. 10, No. 11, No. 12	00000
	9,240

Theoretical Ultimate Load of Joint as Shown.

From No. 1, No. 2, No. 3	1540
From No. 4, No. 5, No. 6	6160
From No. 7, No. 8, No. 9	4620
From No. 10, No. 11, No. 12	00000
	12,320

Summary of Results of Previous Experiments Bearing on Strength of Nailed Joints.

In as far as could be ascertained, no experiments have been made on the transverse strength of the nailed joints made with nails larger than 60d. (6 in.), but from experiments with 60d. and smaller sizes of nails the following general laws have been deduced:—

1. Permissible deflection of a nailed joint 1/16 in. for 60d. nails.

2. Elastic limit of joint will be one-half ultimate strength.

3. Strength of joint is directly proportional to the number of nails used and is independent of relative position of nails when failure does not occur by cracks in timber.

4. The holding power of a nail at the elastic limit is expressed by the equation Cd^2 where C is a constant dependent on the material (5500 for pine, fairly dry) and d. is the diameter of the nail in inches (⅜ in. for 9 in. spikes 4½ to the pound). This holding power is independent of the length of the grip (that is, that part of the nail between the point of application of a shearing load and the point of the nail). It will be noted that according to this equation the elastic limit is entirely dependent upon the material, under a crushing load of the timber.

5. The holding power of a nail at ultimate load varies directly with the length of the grip up to a grip of one-third the length of the nail when it becomes practically constant and is expressed by the equation,

$$\text{Ultimate load} = \frac{2Cd^2 \times \text{grip}}{\frac{1}{3}\text{ length of nail}}$$

In consideration of the fact that wooden joints show a deflection of an inch or more before reaching ultimate load, a brief study of Sketch No. 2 would suggest that the ultimate load on the joint shown must be taken up by the nails in two ways.

(a) By a resistance to withdrawal from the wood.

(b) By a bending of the nail resulting from the shearing force and the resistance to crushing of the wood. Since nails with a grip of an inch or better are bent into very similar curves, this second element does not vary with the grip but is constant. A more reasonable equation for ultimate load for a nail as governed by grip would appear to be

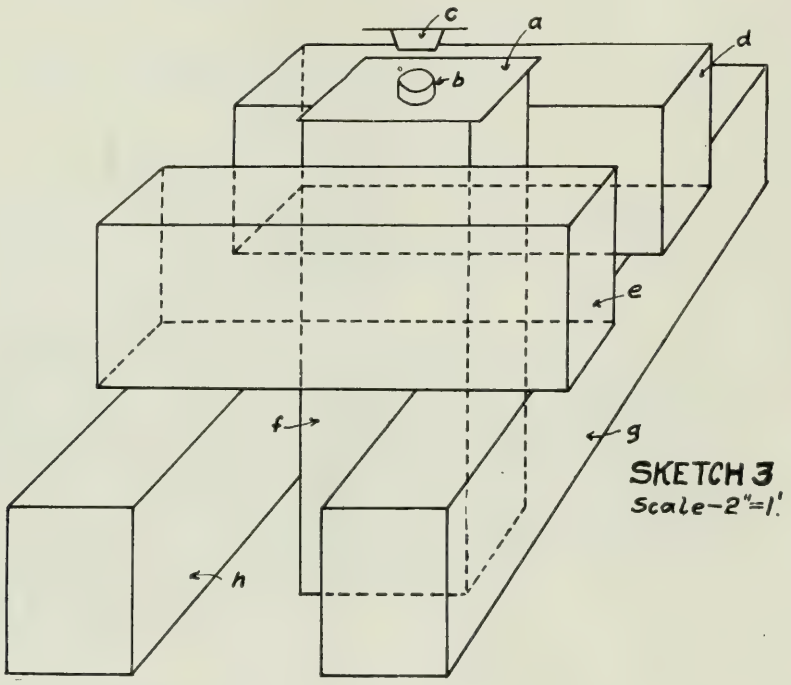
$$(2\ Cd^2 \times \frac{\text{length grip plus X times } Cd^2}{\frac{1}{3} \text{ length nail}}).$$

The value of X as assumed in these experiments was two-thirds. It will be noted that the value of this expression is dependent upon the modulus of elasticity of the timber and the steel in the nails.

failure of the timbers, this was in agreement with the observations.

In experiments Nos. 6 and 7 the nailing was as before, but the timbers were of an intermediate size 4 in. x 8 in. Failure occurred at about the same average load per nail as in experiments Nos. 1, 2 and 3, but while in No. 6 failure occurred by breaking of the timbers, in No. 7 the failure was due to bending and drawing of the nails. The proportioning of nails to timber was, therefore, about correct.

Omitting experiment No. 8 and averaging the values of a 9-in. spike as found in the remaining four experiments where failure took place by drawing of the spikes and using number of nails as found by equation, $\frac{\text{grip in inches}}{\frac{1}{3} \text{ total length}}$ —const., we get 1570 as ultimate load value in shear of 9 in. spike in pine, as against a theoretical value of 1540 pounds. The greatest divergence of a single experiment from the average was 60 pounds.



Notes on Results of Experiment.

To design a well proportioned joint it was necessary first to ascertain the laws governing the holding power of a 9-inch spike in cases where the failure took place by drawing of the spikes, that is, to find the value of one spike, and second to find the limiting number of spikes which would develop their full load (that is, would not cause failure by splitting) in a joint made up of 4 in. x 8 in. pieces. The 8 in. dimension was fixed by the load on the side of the flume under consideration.

Specimens Nos. 1, 2, and 3 were made with 4 in. x 10 in. used as cross pieces (failure by cracking would occur in the cross pieces if at all) and with two, three and four nails per piece respectively. In every case the failure of the joint took place in the nails, and since the results were quite uniform (1580, 1590, 1570 average per nail respectively) it may reasonably be concluded that these values would hold for 9-in. spikes in pine regardless of the dimensions of the timbers.

In experiments Nos. 4 and 5 the number of nails was as before, but the timbers were reduced from 4 in x 10 in. to 3½ in. x 8 in. Failure occurred at a much lower value per nail than with the 4 in. x 10 in., which would suggest a

Supposing the effect of the relation of grip to total length to be as suggested by Merriman, that is, the efficiency of the nail varies as $\frac{\text{grip in inches}}{\frac{1}{3} \text{ total length}}$ up to a grip equal to ⅓ of the length, the average value of a nail as found by the experiments would be 1920 pounds, and the greatest variation from this shown by any experiment would be one hundred and fifty pounds.

Therefore the equation introducing a constant for the effect of the bending of the nails seems, both from the standpoint of theory and observation, to be somewhat the nearer to the truth, though the experiments were far too few in number to in any sense settle this point. The constant assumed, ⅔ Cd^2 where C for the lumber used = 5500, and d = diameter of nail in inches, was in all probability somewhat excessive.

In the light of subsequent experience in actual field construction, the writer would judge that the value of C should be, for commercial grades of pine, somewhat higher than 5500, while the fraction two-thirds might with advantage be reduced to one-third or less.

Adverting to the summary of the results of previous experiments:

(1) The permissible deflection value of 1/16 inch, that is, deflection which can be caused without weakening the joint, is altogether too small. Joints tested to deflections of an inch and more seemed to be in no way weakened. This is a very strong point in favor of the nailed timber joint.

limit, but for practical purposes there can be no doubt that it is at least fifty per cent.

(3) The relation stated between the strength of a joint and the number of nails used, that is, that strength of joint is proportional to number of nails and entirely independent

TABULATED RESULTS OF EXPERIMENT

Number.	DESCRIPTION OF SPECIMEN. CONSTRUCTION. NOTE: See Sketch No. 3.	METHOD OF NAILING NOTE: See Sketch No. 2	REMARKS ON LUMBER USED	Load in pounds at which first signs of failure were noted.	Load in pounds at ultimate failure.	Number of 100% effective nails equivalent to nailing as used. Equation Ult. $L = \frac{\text{grip}}{\text{1-3 length}}$ constant.	Number of 100% effective nails equivalent to nailing as used. Equation Ult. $L = \frac{\text{grip}}{\text{1-3 length}}$ constant.	Observed average ultimate load in pounds per 0.1 in. spike 100% effective grip. Equation $L = \frac{\text{grip}}{\text{1-3 length}}$	Observed average ultimate load in pounds per 0.1 in. spike 100% effective grip = constant. Equation Ult. $L = \frac{\text{grip}}{\text{1-3 length}}$	Calculated ultimate load per 0.1 in. spike 100% effective. Equation Ult. $L = 2\,Cd^2$	Calculated load elastic limit in pounds Equation El. $L = Cd^2$ No. nails No consideration taken length grip	Observed load in pounds at elastic limit of joint	REMARKS
1.—	D. & E: 4 in. x 10 in. F: 4 in. x 8 in.	8 NAILS 2 to each piece of specimen	Pine rough. Fairly dry. Material fair	8200	9500	5 1-3	6	1770	1580	1540	6160	See Foot Note	The values of the joint are the values as governed by the nails.
2.—	D & E: 4 in. x 10 in. F: 4 in. x 8 in.	12 NAILS 3 to each piece of specimen, driven as indicated in Sketch No. 2	Pine rough Fairly dry Good condition	14000	15960	8	10	1990	1590	1540	9240	" "	The values obtained are the values of the joint as governed by the nails for in this case failure resulted from the drawing and bending of the nails
3.—	D & E: 4 in. x 10 in. F: 4 in. x 8 in.	16 NAILS 4 to each piece of specimen, driven as indicated in Sketch No. 2	Pine rough Fairly dry Good condition	19000	21000	10 2-3	13 1-3	1950	1570	1540	12320	" "	The values observed are the values of the joint as governed by the nails for in this case failure took place by the drawing and bending of the nails
4.—	D, E & F: 3⅛ in. x 8 in.	12 NAILS 3 to each piece of specimen, driven as indicated in Sketch No. 2	Pine planed Fairly dry Fair condition	12000	16070	10	12 2-3	1600	1320	1540	9240	" "	The values obtained are the values of the joint as governed by the wood for in this case failure resulted from the cracking of the nails of the piece lettered "E" in Sketch No. 3.
5.—	D, E & F: 3⅛ in. x 8 in.	8 NAILS 2 to each piece of specimen	Pine planed Fairly dry Weather cracked	9840	11550	6 2 3	8	1750	1440	1540	6160	" "	Failure as in No. 4
6.—	D, E & F: 4 in. x 8 in.	12 NAILS 3 to each piece of specimen, driven as indicated in Sketch No. 2	Pine rough Fairly dry Fair condition	14400	16350	8	10	2040	1610	1540	9240	" "	The values obtained are the values of the joint as governed by the wood for in this case failure resulted from the cracking of the nails of the piece lettered "E" in Sketch No. 3
7.—	D, E & F. 4 in. x 8 in.	12 NAILS 3 to each piece of specimen as in Sketch No. 2	Pine rough Fairly dry Fair condition		11[illegible]0	8	10	2000	1[illegible]	1540	9240	" "	The values of the joint are the values as governed by the nails since in this case failure resulted from the drawing of the nails, therefore 1600 represents the holding power of the nail
8.—	D, E & F. 4 in. x 8 in.	9 NAILS 3 Nails with 1 in hold omitted	Pine rough Fairly dry Extra Good material	13000	16[illegible]0	7	8	2160	2[illegible]0	1540	6930	" "	The results from this specimen, as will be noted, show very poor agreement with the other theoretical values or with the observed values of the other seven specimens. This is probably, in part at least, a result of the extra good lumber used. It is included as showing a probable limiting maximum value for the nails.

NOTE:—Observations of Elastic Limit Load were entirely unsatisfactory since the specimens showed large permanent deflections under the first 25% or less of the load but even when the specimen had been stressed almost to the point of failure with corresponding deflections of an inch or more the load could be released and again brought about above the previous high point without causing any material increase in deflection beyond that which had resulted from the first loading

(2) As has been pointed out, no satisfactory results were obtained regarding the relation of elastic limit to ultimate load. The percentage relation of elastic limit to ultimate load would depend on the definition assumed of elastic

of arragemet of nails where failure does not occur by cracking of the timbers, was entirely borne out by the experimental results. Various arrangements of the nails were tried, the nails of almost every specimen being differently spaced, but as will be noted, no material difference in holding power resulted.

COST OF WATER PURIFICATION.

Filter operating costs at the water purification plant at Wilmington, Del., during 1911, averaged $1.08 per million gallons. Preliminary treatment of the water from the Brandywine River by rapid filtration through beds of sponge clippings cost 47.4 cents per million gallons, making a total cost of $1.554 per million. The slow sand plant comprises six units which are washed by a Blaisdell sand-washing machine. The distribution of cost for the slow sand filtration, according to figures given out by Mr. John A. Kienle, chief engineer of the water department, is as follows (in cents per million gallons of water filtered): Salaries, 53.6; additional labor, 10.3; supplies, 6.6; light and power, 16.6; repairs and renewals, 3.5; other operations, 5.0; recaulking groined arch seams, 12.3. During the year 3,680,000,000 gallons passed through the plant. The above charges do not include interest on first cost or laboratory charges. The purification process, on the same basis, cost 49.1 cents per million, distributed among the following items (cents per million): Salaries, 25.3; additional labor, 2.1; supplies, 2.1; light and power, 0.7; repairs, 10.0; other operations, 8.3. Samples of raw and treated water are analyzed daily, the laboratory charges amounting to 47.4 cents per million.

BOILER EXPLOSIONS.

Statistics of the Board of Trade Report of Great Britain for the year 1910 and up to the 22nd of June, 1911, show a total of one hundred and five explosions and sundry mishaps to boilers. A considerable percentage of these explosions occurred in marine boilers at docks or in British waters, the balance are distributed amongst chemical works, engineering works, iron works, copper works, collieries, electrical works and cold storage plants. The chart shown in Fig. 1 illustrates the variety of explosions since the year 1859, when statistics were first compiled. The chart shows the year 1910 to be among the heaviest seasons.

The following tables give the description of the boilers which have exploded or collapsed during the twenty-eight and a half years from June, 1882, when the first Boiler Explosion Act came into operation, to December, 1910, and the causes of these explosions and collapses; and the numbers of explosions, collapses, and mishaps reported on by the Board of Trade, and the total and average number of deaths resulting therefrom during the twenty-seven and a half years ending 31st December, 1909, with the corresponding figures for the year 1910:—

Type of Boiler.	Land Boilers		Boilers Afloat.	
	Number of Explosions.	Number of Collapses.	Number of Explosions.	Number of Collapses.
Plain cylindrical	68	0	0	0
Locomotive and portable.	43	37	0	2
Cornish	40	66	0	0
Vertical, with internal fire-box	25	154	8	35
Lancashire	20	32	0	0
Galloway	0	10	0	0
Chimney	1	6	0	0
Marine	1	0	5	77
Return flue	0	0	7	10
Water-tube	15	0	1	0
Multitubular, externally fired	1	0	0	0
Miscellaneous	25	4	0	3
Hot-water	89	4	0	0
	328	313	21	127

From this report we select a description of a boiler explosion and gas engine explosion rated by the report as a sundry mishap.

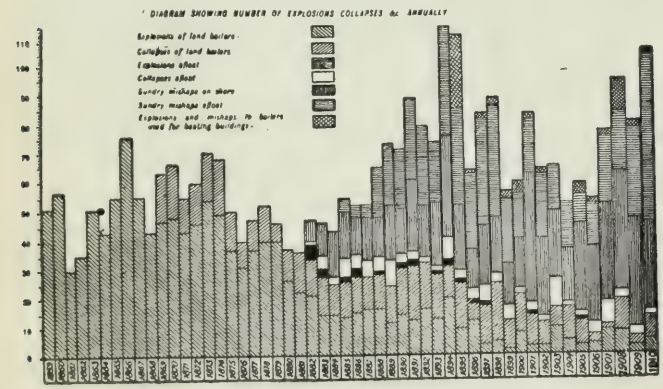


DIAGRAM SHOWING NUMBER OF EXPLOSIONS COLLAPSES &c ANNUALLY
Explosions of land boilers
Collapses of land boilers
Explosions afloat
Collapses afloat
Sundry mishaps on shore
Sundry mishaps afloat
Explosions and mishaps to boilers used for heating buildings

Fig. 1.

On the 18th September, 1910, four Lancashire boilers exploded out of a group of eleven, and displaced the remaining seven from their seats.

The boilers were numbered 1 to 11. Nos. 1 to 7, made in 1880, were of iron, 30 ft. long by about 7 ft. 10 in. diameter. Nos. 8 and 9, made in 1882, were of the same dimensions, but of steel, and Nos. 10 and 11, made in 1894, were also of steel, 7 ft. 6 in. diameter and 32 ft. long.

No. 7 boiler exploded first. Its shell was made up of nine rings, each containing four plates, 7-16 in. thick, lap jointed, double riveted longitudinally, and single riveted circumferentially. The end plates were ½-inch thick, and were stayed by four gussets at each end above the flues, two at the front end and one at the back end below the flues. The internal tubes, 3 ft. diameter, were made up of one furnace ring, 8 ft. long, and six shorter rings, the second, third, fourth, and sixth being stiffened by cross tubes. The plates were 7-16 in. thick, lap jointed and single riveted longitudinally and circumferentially. The end plates were attached to the shell and flues by rings of angle iron, 3 in. by 3 in. by ½ in. There was a manhole, 20 in. by 16 in., with its major axis placed longitudinally on the top of th fifth ring of the shell, strengthened by a cast iron frame. Nos. 1 to 6 boilers were practically the same, also Nos. 8 and 9, except that their shells contained ten rings and their flues seven rings without cross tubes, but stiffened at the circular seams by bowling hoops. Also the manholes were circular instead of oval.

Cause of Explosion or Collapse.	Land Boilers		Boilers Afloat.	
	Number of Explosions.	Number of Collapses.	Number of Explosions.	Number of Collapses.
Corrosion	106	150	11	18
Grooving	29	4	0	0
Excessive pressure	33	27	3	9
Outlets frozen	70	4	0	0
Failure of stays	15	13	0	4
Deficiency of water	19	68	0	53
Structural weakness	15	29	1	4
Fractures	14	2	0	0
General deterioration	5	0	4	0
Seam rips	7	0	0	0
Deposit	13	12	0	35
Not ascertained	2	4	2	4
	328	313	21	127

Each of these boilers had one safety valve, 3½ in. diameter, fitted on a branch on the junction valve casing, loaded by a lever and weight to 45 lbs. per square inch. Nos. 10 and 11 were stronger boilers, and each had two independent safety valves fitted directly to the boiler shell.

The boilers were fed with good water and fired by waste gases from blast-furnaces. They were in good condition and well looked after.

No. 7 boiler was laid off for cleaning on the evening of the 16th September, and set to work again by turning on the gas at 1.45 p.m. on the 18th September. At 3.30 p.m. the pressure gauge indicated 45 lbs. per square inch, and the stop valve was opened to put the boiler in communication with the other boilers. At 5.15 p.m. the explosion occurred—fortunately, during the temporary absence of the attendant.

The boiler was torn into more than forty pieces, some of which were blown to a great height. Two of the pieces struck Nos. 6 and 8 boilers, and caused them to explode,

and in like manner the explosion of No. 6 caused the explosion of No. 5. The rest of the boilers, with the exception of No. 1. were crushed out of shape, and all were displaced from their seatings. The order of the proceedings is described with admirable lucidity in the report of the Board of Trade surveyors, who made the preliminary enquiry after the explosion, but the description is unfortunately too long to be inserted here.

It is shown that the cause was excessive pressure, probably about 150 lbs. per square inch, and that rupture commenced at the manhole and extended from it in three main lines, one longitudinally backward, the other two diagonally forwards, at about 30 deg. on each side of a line drawn along the top of the boiler, parallel to its longitudinal axis.

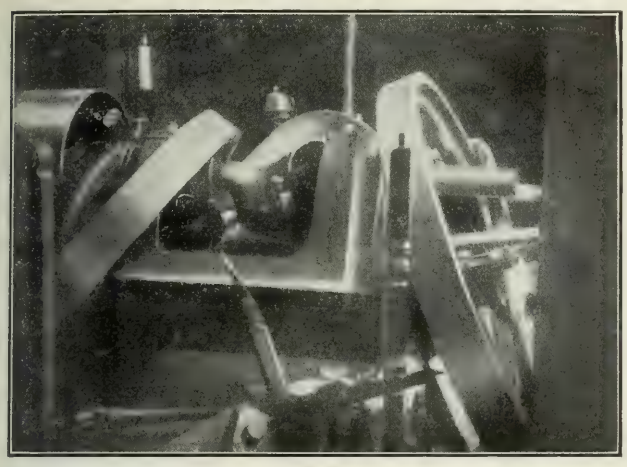


Fig. 2.

The cause of the excessive pressure was the insertion of a plug in the opening for the junction valve, which was leaking, to prevent the hot water dropping on to the men who were cleaning the boiler. By plugging the outlet for the steam the safety valve, which was attached to the side of the stop-valve casing, was cut off from the boiler and rendered inoperative.

The boiler was insured and inspected by the National Boiler and General Insurance Company, who had pointed out the dangerous position of the safety valve and the possible occurrence of what actually happened.

After the enquiry the No. 1 boiler, which, though displuaced from its seating, was uninjured, by the explosion, was tested to destruction to ascertain the pressure at which the manhole would give way. The pressure was found to be 145 lbs. per square inch.

The gas engine explosion occurred in a horizontal engine of unknown age, with cylinder 8½ in. diameter by 15 in. stroke, running at 160 revolutions per minute, with gas from a town main. The air for the cylinder charges was drawn from the interior of the bedplate, to which it was admitted through slots in one side. If by any means, such as leakage past a slightly open gas cock, gas should be forced into the cylinder during a stoppage of the engine, and if the engine should be stopped with the exhaust valve open, the space inside the bed would be filled with a combustible mixture of gas and air which might easily be fired when restarting. Something of the kind evidently occurred in the present instance. The engine had been stopped about an hour to repair the driving belt, and on restarting an explosion occurred inside the bedplate. The bedplate and a large casting on which it stood were shattered beyond repair, all the arms of both flywheels were broken, and the rims detached from them, besides minor damage. A photograph of the engine after breakdown is reproduced by Fig. 2.

A BEAM AND GIRDER SYSTEM vs. MUSHROOM.

Lockwood, Greene & Co., Boston and Chicago architects and engineers for industrial plants, recently had occasion to make comparative estimates on the cost of reinforced concrete for a 10-story warehouse 580 feet long by 109 feet wide, using beam and girder construction and a mushroom system. Unit prices were obtained from the records of work done in the vicinity in question and were as near correct as was possible to obtain for a preliminary estimate. It should be noted that the figures below do not include plant and tools or any items that would be common to both systems, and therefore should not be taken in any way as an estimate of the cost of the building. The quantities in the following table are based on one strip of floor 19 feet 3 inches wide and the height of the structure. It will be noted that the total cost per strip for the beam and girder system is $12,616, while for the mushroom design $12,432, leaving a net saving in favor of the mushroom system of $184 per strip, or $5,520 for the entire building.

The cubic yard price on 1:2:4 concrete is obtained as follows:—

Cement, 1⅔ at $1.10 net	$1.80
Sand, ½ yard	.40
Stone, 1 yard	1.00
Labor	1.00
Sundries	.10
Total	$4.30 yd.

Columns cost 70 cents per yard more for labor.

1½:3 concrete cost $1 more per yard for cement, making cost of $5 per yard for columns.

Mushroom Estimate.

Concrete 1:2:4 interior cols.=97 cu. yds., at $5.00..	$ 485
Concrete 1:1½:3 wall cols.=34 cu. yds., at $6.00..	204
Concrete in floors, including slab, capitals and wall beams=675 cu. yds. at 4.30	2,902
Forms for columns, 6,000 sq. ft. at 12c	720
Forms for column heads, 40 sq. ft. at $3.00	120
Forms for interior wall, 20 sq. ft. at $2.00	40
Forms for floor including slab and wall beams, 21,850 sq. ft. at 8c	1,748
Steel reinforcement (cost includes facing, 51 tons at 34c.)	1,734
Steel lattice columns, 58 tons at 52c	3,016
Erecting lattice columns, 32 tons at 5c	160
Brick work, 11 M at 18c	198
Windows, 2,690 sq. ft. at 30½c	807
Royalty	208
	$12,432

Beam and Girder Estimate.

Concrete 1:2:4 interior cols., 75 cu. yds. at $5.00...	$ 375
Concrete 1:1½:3 wall cols., 32.5 cu. yds. at $6.00..	195
Concrete in floor inc. beams, girders and slabs, 550 cu. yds. at $4.30	2,365
Forms for columns, 6,300 sq. ft. at 12c	756
Forms for floors, inc. beams, girders and slabs, 30,600 sq. ft., 9c.	2,754
Haunches, 80 sq. ft., $1.00	80
Steel reinforcing (cost inc. placing), 63 tons at $37	2,331
Bethlehem steel cols., 54 tons at $45.00	2,430
Erecting, 32 tons at $5.00	160
Brickwork, 20 M, at $18.00	360
Windows, 2,700 sq. ft. at 30c	810
	$12,616

A NEW HYDRAULIC VALVE.

A new type of hydraulic valve has recently been installed in the Ontario Power Company power house at Niagara Falls. The valve was designed and the principle patented by Mr. R. D. Johnson, the hydraulic engineer of the power company. Fig. 1 shows the section through the valve. The common type of sluice valve now in use works very well for low pressure and small dimensions. Such a valve is operated by hand wheel or spindle fitted with appropriate gearing. The larger types of gate valves under high pressures, are usually fitted with a by-pass and may be operated either hydraulically or by electric motors. The gate valve, however, for high pressure and large diameters is very difficult to operate.

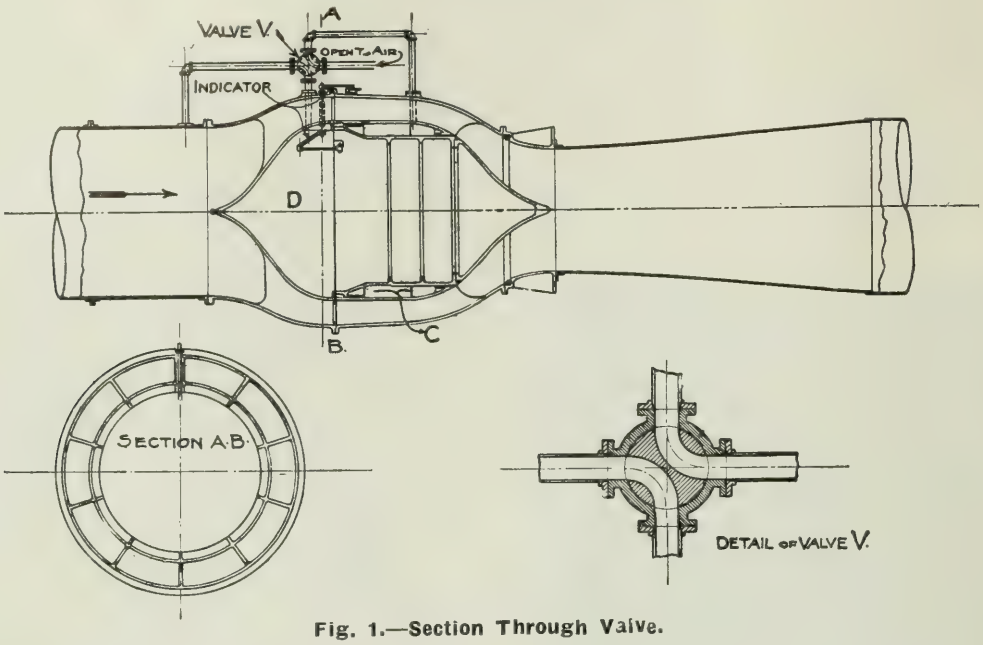


Fig. 1.—Section Through Valve.

Mr. Johnson designed this new type of piston valve to get over these difficulties. The operation of this valve is due to the difference of pressures causd by the changes in velocity of the water in the valve case. The valve, it will be noted, is composed of an enlarged and contracted section of pipe following each other closely. Inside the enlarged section is placed a stationary plunger, or bobbin, with the lower section moveable and telescoping into the upper section. When closed, the lower portion of the bobbin seats itself on a brass ring (shown in Fig 1) at the beginning of the restricted section of pipe. The opening of the valve is due to the static pressure on the submerged surface of the plunger above the valve seat. The closing work of the valve equals the static pressure inside the moveable plunger. As shown in Fig. 1, an indicator may be attached to control valve to exclude possibility of the main valve creeping from any desired opening. Valve V is a four-way valve by means of which different connections, as shown in Fig. 1, may be made. The annular chamber C is a leakage chamber. If the water is free to flow when the main valve is open, chamber C may be omitted by merging it into chamber D. Its presence is desirable as an efficient factor of safety. The valve V, in the position shown in Fig. 1, reduces the pressure in the annular chamber C to atmospheric, and the main valve closes due to full pressure transmitted into chamber D. Reversing the control valve reverses the pressure, and the main valve opens. This valve has many advantages over the ordinary gate valve, for it is simple in operation, possesses great strength, all of the parts being circular, and it is absolutely safe in operation. The valve can be designed for any dimension and any head.

Fig. 2 illustrates a 48-inch valve of this type installed at the Ontario Power Company, Niagara Falls. Two of these are placed on the exciter penstocks there. These valves are to be operated by electrical control from the power house. They have already been placed in operation and they work most satisfactorily. The two valves at the Ontario Power Company were manufactured by the Böving Company, of London, England, who hold the British patents and have offices in Toronto.

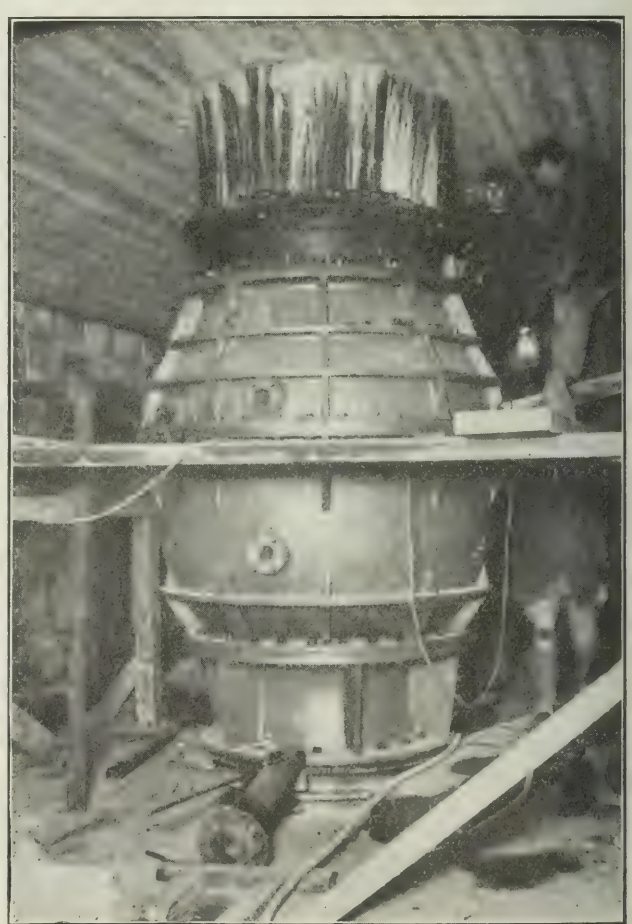


Fig. 2.—Erection of 48-inch Exciter Penstock Valve.

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PREVENTION OF INDUSTRIAL ACCIDENTS.

At different times we have referred to the number of accidents occurring, and which appear to be on the increase. The majority of these accidents can be traced to carelessness, thoughtlessness, or selfishness on the part of some one, and it is, therefore, refreshing to hear that certain companies are taking measures to reduce the number of industrial accidents. Industrial accidents are those which result from the use of machinery. The Pennsylvania Railroad began a vigorous campaign of education among their employees a little over a year ago. In January, 1911, the percentage of serious injuries per month per thousand employees was 8.7. This has been reduced in less than a year to 3.5. In November, 1910, when this campaign of education was begun, experts were employed by the company to inspect the shops with a view to the installation of safety devices for the prevention of accidents. The results obtained from following the suggestions of the experts were so marked that the continuation of these inspections has become a fixed policy. The installation of the necessary protections for the machines was not very costly, in some cases the improvements being made with practically no expense to the company. Standing safety committees were formed from among the employees, for it was appreciated that the prevention of accidents depended largely on the care exercised by the individual workman. By this means many of the common and preventable accidents were avoided. The recommendations of these committees cover a wide variety of subjects, and have been the means of preventing many of the accidents so prevalent heretofore.

So successful has been the work during the past year that the Pennsylvania company are redoubling their efforts to reduce industrial accidents during the coming year. This same policy, if taken up by the small manufacturing companies and shops throughout the country, would do much towards wiping out this stain on our industrial life. In most cases there is little excuse for the numberless accidents, many of these occurring as a result of carelessness on the part of employer or employee. By the installation of safety devices and protection, the class of unavoidable accidents is reduced, and by the education of the employee the preventable accidents are avoided.

THE PUBLIC AND THE STREET RAILWAYS.

The hostility of the public towards public utility corporations has been on the increase during the past few years. In our larger cities a constant warfare is being waged between the companies operating under franchises voted by the citizens and the citizens themselves. It is hardly possible to pick up a daily newspaper without seeing column after column devoted to this conflict of corporation interests and public demands.

This is a good reason for much of the public objection to the carrying on of companies operating under municipal charters, for the companies have not as yet recognized the necessity of meeting the municipalities and co-operating for mutual benefit. Publicity of the methods of operation would no doubt do a great deal towards dissipating the constantly developing irritating points of contact. In one of the addresses at the convention of the American Electric Railway Association, held in New York during January last, the benefits of a consistent policy of publicity were outlined. Some of

the ideas expressed, if taken up and carried on vigorously by our Canadian street railway companies, would engender a different public sentiment. The ignorance of the public in the fundamental requirements necessary for successful electric railway operation is productive in many cases of unfavorable feeling on the part of the citizens. In regard to the actual details of service the people are in ignorance. Very few men know the cost of equipment, the cost of operation and the cost of maintenance, and as a result are unable to appreciate the reasonable limitations of service.

It must be appreciated that electric railway operation in the cities provides almost unlimited opportunity for disatisfaction, and this is all the more intensified by the lack of knowledge of conditions. To quote from the address referred to above, it is no longer a matter of opinion, but a demonstrated fact that it is quite possible so to educate the public that it will be almost reasonable; that it will not always expect the impossible, and will not, owing to ignorance, insist upon the enactment of punitive legislation, fares below cost of operation, overtaxation and onerous regulation.

The increase in the efficiency of equipment and operation of electric railways in our large cities has not been accompanied by a decrease in the volume of criticism, and for this condition the companies must blame themselves. The managers of these companies, instead of striving to promote a feeling of co-operation and friendship with the citizens, have taken the position of antagonism and demanded the full equivalent their franchises allowed them.

By consistently educating the public in the different elements necessary for the success of the system, both in returns to the company and in the maximum of efficient service to the people, this feeling of antagonism will be gradually dissipated and the companies will find that their position in the community has become one of benefit. The public will also appreciate the fact that the companies are entitled to their reasonable demands in order to provide efficient service and fair returns to the investors. This policy of education on the part of the companies must come, or their present attitude of antagonism will force the increase of public ownership of these utilities.

EDITORIAL COMMENT.

A notable increase in the production of stone, brick and other structural materials was recorded during 1911 in the Province of Quebec. This increase in a measure is due to a more thorough collection of data and returns, but nevertheless it is sufficient to consider the development, the increase and the progress of the industries in general in the Province of Quebec, to realize that the market for structural materials has increased tremendously in the last few years, and will continue to do so for many years to come.

* * * *

The Chicago Drainage Canal is again the subject of controversy. There is now a proposal before the United States Senate to increase the flow by 6,000 cubic feet per second over the amount now used. This is a most difficult question to decide, for many interests, both Canadian and American, will be affected if the request is granted. It is generally accepted that the increased diversion will mean a drop of some three or four inches in the lake levels, and will thus affect navigation, and by the decreased flow over the Niagara Falls will affect the power question there.

There is a movement under foot to secure funds for the illumination of Niagara Falls. A bill has been introduced in the New York Senate to provide an appropriation of $50,000 for construction and installation and $2,500 for one year's operation of an illuminating plant for this purpose. The Province of Ontario have also been asked to provide a like sum. This scheme has been advocated for some years back, and it looks as if it were at last to be realized.

* * * *

There is a bill now before the Ontario Legislature to regulate the width of tires on wagons and other vehicles. The bill provides that after the 1st of January, 1914, no vehicle shall be driven on a public highway in Ontario unless its tires are the width prescribed. We are glad to see that the provincial government have begun to appreciate the necessity of taking measures to prevent the destruction of the highways. There is little use in putting down good roads if no restriction is placed on the loading of vehicles and the width of tires used. It is to be hoped that the bill will be passed and become law.

GENERAL NOTES.

In Quebec, Prince Edward Island, and very locally in Northern New Brunswick and Ontario, the total precipitation was in excess of the average, while in other parts of Canada it was deficient, and in the Western Provinces only amounted to about one-third of the usual quantity. At the close of the month the ground was snow-covered throughout Canada, except on the Pacific Coast and the Lower Mainland of British Columbia, where the snow had disappeared. Considerable snow has been deposited on the mountains of British Columbia, but the depth is, in most places, less than last year. In the Western Provinces the depth is generally about five inches, but in Northeastern Saskatchewan and in Keewatin the snow on the ground is from fourteen to twenty-four inches deep. The snow covering in Ontario varies in depth with the district, the Highlands and eastern part of the upper country and the Ottawa Valley being covered by from twenty to thirty-six inches, while in other districts the depth is from six to ten inches. In Quebec, a depth of twenty-six inches at Montreal increased eastward to about sixty inches in the Gaspé Peninsula.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for February, 1912:—

	Depth in inches	Departure from the average of twenty years
Calgary, Alta.	0.1	—0.45
Edmonton, Alta.	0.2	—0.54
Swift Current, Sask.	0.4	—0.25
Winnipeg, Man.	0.2	—0.09
Port Stanley, Ont.	2.8	—0.18
Toronto, Ont.	1.67	—0.65
Parry Sound, Ont.	2.6	—0.63
Ottawa, Ont.	2.9	+0.40
Kingston, Ont.	1.1	—0.99
Montreal, Que.	4.3	+1.07
Quebec, Que.	2.2	—0.86
Chatham, N.B.	2.7	—0.09
Halifax, N.S.	2.8	—1.72
Victoria, B.C.	3.1	—0.47
Kamloops, B.C.	0.5	—0.31

THE RELATION OF THE PUTRESCIBILITY OF THE SETTLING AND NON-SETTLING SUSPENDED MATTER IN SEWAGE.*

By Dr. Arthur Lederer.

When we speak of a raw sewage being "strong" or "weak" we have, ordinarily, factors in mind which are furnished by the chemical determinations of total organic nitrogen, organic carbon, chlorine, and possibly fats. To one who is dealing continuously with one and the same sewage the suspended matter will give a fairly good idea of the strength of the sewage. It is likewise apparent that certain relations can be established between some of the chemical constituents from a long series of analyses. However, in different localities all these factors and relations will be subject to modifications, the chief cause for which lies in the varieties of trade wastes likely to be present in the majority of American sewages. In a general way a stronger domestic sewage will require more dilution in a water course than will a weaker, as expressed by any of these factors above.

Up to the time of the introduction of the methylene blue putrescibility test, we have lacked a definite expression for the strength of a sewage from the standpoint of a prospective nuisance. Since the vast majority of sewages reach the surface water in an unpurified or partially purified state, it is clear that any determination in which the natural agencies participate (as is the case in the putrescibility test of Spitta and Weldert) must of necessity come closer to the actual changes occurring in water courses than a purely chemical test, such as the determination or "oxygen consumed." This is the more apparent when we consider that the different methods in vogue of determining "oxygen consumed" give rise to very perceptible differences in the results. The methylene blue putrescibility test, as is well known, depends upon the formation of a colorless leucobase as the oxygen in the sample becomes exhausted. The test has been made more valuable by Phelps, who worked out relative stability figures which serve as a numerical measure of the relation between the available oxygen and the oxygen required for complete oxidization. Since the reaction is a biologic one, an incubation temperature of 20° C. will favor the development of bacteria likely to take part in the self-purification of rivers, while a temperature of 38° C. will favor the development of a bacterial flora not likely to take part in nature. The methylene blue test is at present almost universally used in sewage purification plants, and rightly so, for its purpose well. The main objection to the test, however, has been the time which is consumed to obtain results. This is the chief reason why sometimes an incubation temperature of 38° C. is preferred t othe more desirable temperature of 30° C.

Recently interest was awakened in the test for the loss of dissolved oxygen in a sewage mixture on incubation for a definite period of time under anaerobic conditions. The loss of oxygen, as determined quantitatively, serves as a measure of the stability of the sewage or the sewage mixture. This test is a more direct measure of the probable effect upon the stream than the methylene blue test. The test is not a new one. On looking over German literature repeated mention is found of "Sauerstoffzehrung" among the analytical data, the result of which is obtained by methods substantially the same as described above. Mention was first made of the results obtained with this method in this country in the report of the Lawrence Experiment Station for the year 1900 (Mass. State Board of Health). The test was also referred to recently as a good measure of stability by the writer, and by C. B. Hoover, of the Columbus Sewage Works. Hoover likewise recognized that the analytical results usually employed to show the degree of purification effected by sewage treatment do not reveal quantitatively the relative stability, and hence can not be looked upon as reliable indices of the deoxygenerating properties of sewages, sewage mixtures or effluents. As a result of a long series of tests he obtained certain definite relations for sewages, septic effluents and filter effluents as determined from a modified "oxygen consumed" test and the loss of dissolved oxygen on incubation, described previously. It may be possible to establish such a relation in dealing with one and the same sewage for a long time, but the relation is bound to differ in various places to a great extent. The method does not lend itself to a ready expression of the stability. Hoover measured his loss of dissolved oxygen by incubation at 37° C. for 24 hours. There is a possibility, as Phelps has pointed out, in certain effluents, particularly those from rapid filters, of oxygen becoming lost at this temperature without being consumed. The saturation point of oxygen at 37° C. is not over 7 p.p.m., and consequently there is a tendency for some of the dissolved oxygen to escape. Tight stoppers are not likely to prevent the escape of the released gas, nor are mercury seals adapted for routine work.

Recently Phelps introduced his method of calculating quantitatively the stability of a sewage mixture from determinations made by anaerobic incubation at 20° C. for a

Table I.

	Parts per Million												Per Cent. Permissible Sewage.		
	Solids in Crude Sewage.		Suspended Matter. After Four Hours Settling.				Oxygen Consumed			Organic Nitrogen.					
Serial No.	Total.	Volatile.	Original. Total.	Original. Volatile.	Total.	Volatile.	Crude.	Settled.	Filtered.	Crude.	Settled.	Filtered.	Crude.	Settled.	Filtered.
1	493	222	68	50	37	30	13.	5.5	46.	7.5	5.1	4.6	24.6	27.5	42.
2	629	313	266	124	91	55	29.	17.	11.	9.5	..	11.0	18.3	19.2	51.
3	594	295	118	84	45	43	30.	25.	20.	7.1	..	20.	4.2	5.0	11.1
4	630	335	162	119	52	40	37.	33.	23.	13.7	11.3	23.	2.6	5.5	9.4
5	680	385	194	126	75	55	52.	33.	26.	11.9	7.1	26.	5.0	7.3	11.8
6	654	344	227	127	67	44	51.	28.	23.	12.3	3.3	23.	4.7	10.3	21.3
7	592	322	187	120	65	57	52.	37.	29.	10.5	5.5	29.	3.0	5.4	13.3
8	642	318	206	107	65	50	45.	31.	21.	13.0	..	21.	10.1	18.3	29.4
9	547	270	76	52	51	44	27.	25.	24.	5.9	4.8	24.	17.7	19.1	20.8
Avg. 607		311	167	101	61	46	37.	26.	20.1	10.1	..	20.1	10.0	13.1	24.3

*A paper read at the annual meeting of the American Public Health Association at Havana, Cuba, Dec. 4 to 9, 1911.

given period of time. The sewages are mixed with water saturated with oxygen, and the total amount of oxygen is determined directly. The sample is then stored in a tight bottle for a suitable period of time and the oxygen redetermined. The rate at which the oxygen disappears under these conditions is a direct measure of the probable occurrence upon a stream. Under given assumptions, other than those actually occurring in a specific test, the following formula derived by Phelps may be used:

$$C = \log (O^1/O) \div Kt$$

In this formula C represents the percentage of sewage permissible in the water used for dilution under the assumed conditions. O^1 is equivalent to the dissolved oxygen in the mixture before incubation expressed in parts per million, O the dissolved oxygen after incubation. K is a constant which defines mathematically the rapidity with which the oxygen is used up in a mixture of water and sewage. From a specific test K is determined. The formula can then be applied to other cases. According to Phelps K depends upon the character of the sewage matter and the concentration of that material in the sewage, and is independent of the extent of dilution or the character of the diluting water. Subsequent experiments made by the writer on crude sewages at the Sewage Testing Station of the Sanitary District of Chicago have proven, however, that the factor K is not independent of the amount of dilution. t represents in the formula the time which is allowed for the contact of water and sewage to produce the change in the oxygen of the mixture.

It occurred to the writer to utilize Phelps' quantitative expression of the stability of sewages to demonstrate the improvement of the liquid by the removal of the settling suspended matter and complete removal of all the suspended matter. The laboratory technique employed for these experiments was the same as employed by Phelps. Two dilutions were made as a rule on one and the same sewage. A dilution of 1 part of sewage to 8 and 10 parts of water from Lake Michigan has given satisfactory results. The time of incubation was 24 hours, and the temperature of incubation employed 20° C. The sewage was mixed with the lake water in a glass cylinder by a specially devised stirring apparatus to insure the least possible aeration. A portion of the same sewage was also filtered through a single layer of Swedish filter paper, which removed all suspended matter and pseudo colloids. The same dilutions were made as with crude sewage and the initial dissolved oxygen determined just as in the crude sewage mixtures. The same dilutions were also made on another portion of the sewage after the suspended matter had been allowed to settle for 4 hours. Citrate of magnesia bottles. with patent stoppers, obtainable at any drug store, have proven very efficient for these incubation experiments. They do not permit air to enter as do some of the bottles provided with ground stoppers.

All the results obtained were calculated on the basis of preserving 30 per cent. residual oxygen after a 24-hour period of contact or flow. Besides this test other tests were carried on, such as total solids, oxygen consumed, and organic nitrogen, in order to bring out the relation of the volatile organic carbonaceous and nitrogenous matter in solution and suspension to the calculated permissible dilution. As mentioned previously, the factor K in Phelps' formula has not been found to be independent of the dilution. Special experiments carried on with three different dilutions on the same sewage have clearly shown that K will decrease with a lower dilution, and the factor C of course will be found to be correspondingly higher. It was further found that the difference in K between the lower dilutions is greater than the difference between the two higher dilutions. As yet the results have not demonstrated a constant difference between C (the percentage of sewage) resulting from the various dilutions, consequently an exponent has not been introduced in the original formula. The highest C value has been used to compare results. Values of one and the same dilution only are given for a comparison of the permissible percentage of crude, settled and filtered sewages in Table 1. On the whole, the differences in the factor K in the different dilutions have not been materially different, and are hardly large enough to interfere with the intelligent interpretation of the results (Table 1.) The striking feature of this table is the last column, indicating the ratio of dilution or the "per cent. permissible sewage" (C) of the filtered sewage as compared to the raw and settled sewage. The remarkable result is still more apparent in Table 2, which indicates the improvement in percentages.

Table II.

Serial No.	Suspended Matter. Per Cent. Removed by Settling. Total.	Volatile.	Per Cent of Additional per Cent. Removed by Filtration. Total.	Volatile.	Volatile Matter Left in Solution After. Settling.	Filtration.	Per Cent. Reduction of Oxygen Consumed. Settling.	Filtered.	Per Cent. Improvement in Permissible Sewage. Settling.	Filtered.
1	46	40	54	60	91	78	58	65	11	71
2	66	56	34	44	78	60	41	62	5	179
3	62	49	38	51	86	71	17	33	19	164
4	68	66	32	34	76	65	11	38	111	262
5	61	56	39	44	81	67	37	50	46	136
6	71	65	29	35	76	63	45	55	119	353
7	65	53	35	47	80	63	29	44	80	343
8	68	53	32	47	82	66	31	53	81	192
9	33	15	67	85	97	81	7	11	8	68
Avg.	63	54	37	46	82	68	30	46	31	143

Looking over the average of the nine experiments in Table 2 we note, for instance, that on removal of 63 per cent. of the total suspended matter, or 54 per cent. of the suspended volatile matter, the actual improvement in the sewage from the standpoint of a prospective nuisance is but 31 per cent. Results similar to this have been obtained by C. B. Hoover. The sewages with the low suspended matter (experiments 1 and 9) have the low percentage improvement. One exception is found in experiment 2 with a high suspended matter and a low improvement from a dilution standpoint. Now, when we turn to the results obtained by filtration we will note in Table 2 that the removal of only 37 per cent. of suspended matter, or 46 per cent. volatile suspended matter additional to sedimentation has shown an improvement of 143 per cent. for dilution purposes, or nearly five times the improvement gained by merely settling the sewage. Similar is the case with the carbonaceous matter as expressed in "oxygen consumed." A reduction of 30 per cent. of "oxygen consumed" is equivalent to an improvement of 31 per cent. in dilution, while an additional removal of 16 per cent. in "oxygen consumed" gives an actual additional improvement of 112 per cent.

A thorough study of these two tables will clearly bring out the fact that the removal of suspended matter capable of settling in settling tanks constitutes an improvement from the dilution standpoint much less than the percentage of suspended matter removed. Since we have to consider the improvement of any sewage or effluent from the standpoint of the degree of dilution required rather than from the standpoint of the reduction of any chemical constituents (as shown by analysis), the improvement made by settling con-

sists mainly in the improvement of the physical character of the liquid by the removal of material which may cause deposits, and incidentally some improvement in the stability. However, the removal of an additional small quantity of suspended matter not capable of settling, by simple filtration will improve the liquid far out of proportion to the percentage of volatile matter removed. This permits of only one conclusion, that is, on a domestic sewage from a large area the finely divided slowly settling suspended matter and pseudo colloidal matter not capable of settling make up the greater part of the putrescibility, due to the suspended and colloidal matter. This fact has been recognized before. Spillner states that the organic sulphur compounds in sewages which afford the material for the development of hydrogen sulphide are found in much smaller quantity in the suspended matter capable of settling than in the dissolved colloidal and finely suspended matter which has been removed by filtration in these experiments.

In the present state of the science of sewage disposal we aim to destroy the finely suspended matters by oxidization. However, most of the sewage is discharged to-day either in a raw or settled state. If a device can be worked out to take care of the finely divided non-settling suspended matters without resorting to biologic treatment, a degree of purification may possibly be attained intermediate between settling and biological treatment, which in many cases may be sufficient to avoid the expense of the more thorough biological treatment.

In conclusion the writer wishes to express his thanks to Prof. E. B. Phelps, of Boston, and to Mr. Langdon Pearse, engineer-in-charge of sewage disposal experiments in Chicago, for valuable suggestions, and further to Messrs. H. B. Hommon and F. Bachmann for their conscientious analytical work.

CANADA'S MINERAL PRODUCTION

The total value of the mineral production in Canada in 1910, according to revised statistics now complete, was $106,823,623. Compared with the previous year's production of $91,831,441, that of 1910 shows an increase of $14,992,182, or 16 per cent., and, says Mr. John McLeish, B.A., in his report to the Department of Mines, Ottawa, is the largest increase that has been recorded in Canada's mineral production in any one year. The production per capita has also increased from $12.82 in 1909, to $14.26 in 1910, an advance of 11.2 per cent. The largest production per capita previously recorded was $13.35 in 1907.

The year 1886 was the first year for which complete statistics of mineral production for the whole of Canada were collected, and the production that year was reported as $10,221,255, or about $2.23 per capita. In ten years the production had increased over 100 per cent., to $22,474,256, or $4.38 per capita, in 1896. At this time the Yukon began to contribute largely to the gold production, and, during the next five years, an increase of nearly 200 per cent. is shown, the total reaching a value of $65,797,911, or $12.25 per capita in 1901. The next three years witnessed a slight falling off, but from 1904 the production again rapidly increased to its present high record.

The production of metalliferous products in 1910 was valued at $49,438,873, being 46 per cent. of the total mineral output; and an increase in value over the previous year of $5,282,032, or nearly 12 per cent. The value of non-metalliferous products (excluding structural material and clays) in 1910 was $37,757,158, being 35 per cent. of the total mineral output; and an increase of $6,615,907, or 21 per cent. in value over 1909. The value of the production of clay, lime and stone, and other structural materials in 1910 was $19,627,592, or 18 per cent. of the total production; and an increase of $3,094,243 over the 1909 output.

Amongst the more important minerals mined, coal occupied first place, contributing about 29 per cent. of the total production; silver, next in importance, contributed over 16 per cent. of the total; nickel was next in order with over 10 per cent; while gold occupied fourth place with 9½ per cent. of the total; clay products contributed 7 per cent.; copper 6.6 per cent.; cement 6 per cent.

The increased production was not confined to a few products, but was, on the other hand, fairly well distributed throughout the list of ores and minerals mined in Canada. Amongst the metallic products the principal increases were in silver, nickel, gold and copper; there being a falling off in the production of lead and of zinc. There was an increased production of pig iron from blast furnaces, but a smaller amount credited to Canadian iron ore.

The prices of metals upon which the value of the production directly depends did not vary greatly during the year, nor did the averages differ much from those of the previous year. Lead, silver and zinc averaged higher in price in 1910, while copper was fractionally lower and nickel remained practically at the same price level.

The total value of the exports of products of the mine, including direct mine products and manufactures, in 1910 was $51,856,862, as compared with $47,442,001 in 1909. This value includes for 1910 mine products to the value of $42,236,270 and manufactures valued at $9,620,592. About 93 per cent. of the value of the mine products exported is made up by silver, nickel, copper, gold, coal and asbestos. Manufactured mine products consist chiefly of iron and steel goods, coke, and aluminum, made from imported ore.

The United States is the chief destination of Canada's mine exports, about 83 per cent. having been exported to that country during the fiscal year 1909-1910, and about 9 per cent. to Great Britain.

The following table shows the mineral production by provinces for the year 1899 to 1910, inclusive:—

	Nova Scotia.	New Brunswick.	Quebec.	Ontario.	Manitoba.
	$	$	$	$	$
1899	6,817,274	420,227	2,585,635	9,819,557	
1900	9,298,479	439,060	3,292,383	11,258,099	
1901	7,770,159	467,985	3,759,984	13,970,010	
1902	10,686,549	607,129	3,743,636	14,619,091	
1903	11,431,914	580,495	3,585,938	14,160,033	
1904	11,212,746	559,913	3,688,482	12,582,843	
1905	11,507,047	559,035	4,405,975	18,833,292	
1906	12,894,303	646,328	5,242,058	25,111,682	
1907	14,532,040	664,647	6,205,553	30,381,638	898,775
1908	14,487,108	579,816	6,372,949	30,623,812	584,374
1909	12,504,810	657,035	7,086,265	37,374,577	1,193,377
1910	14,195,730	581,942	8,270,136	43,538,078	1,500,359

	Alberta.	Saskatchewan.	Yukon.	British Columbia.	Total.
	$	$	$	$	$
1899	17,108,707			12,482,605	49,234,005
1900	23,452,330			16,680,526	64,420,877
1901	19,297,940			20,531,833	65,797,911
1902	16,127,400			17,448,031	63,231,836
1903	14,082,986			17,899,147	61,740,513
1904	12,713,613			19,325,174	60,082,771
1905	11,387,642			22,386,008	69,078,999
1906	10,092,726			25,299,600	79,286,697
1907	4,657,524	533,251	3,335,898	25,656,056	86,865,202
1908	5,122,505	413,212	3,669,290	23,704,035	85,557,101
1909	6,047,447	456,246	4,032,678	22,479,006	91,831,441
1910	8,996,210	498,122	4,764,474	24,478,572	106,823,623

TURBINE PUMPS.

A paper on "The Evolution and Present Development of the Turbine-Pump," by Dr. Edward Hopkinson and Mr. Alan E. L. Chorlton, was read before the Institution of Mechanical Engineers of Great Britain recently.

To-day, they said, the turbine principle seemed the accepted ideal for almost all primary machines, and it would appear that the age of the reciprocating engine for the various work of mechanical engineering, was passing and that the rotary engine of the turbine type was steadily taking its place. In that of steam prime-movers it had, perhaps, already taken the lead over the reciprocating type, and the engine of Watt must now be relegated to second place. In other fields and duties its progress to date was so great as to warrant the surmise that at no distant time a similar comparison of precedence would be made. Perhaps in no domain had the turbine rotary principle achieved greater success in the last few years than in high-lift pumping, though probably the realization of its possibilities for such duties was as old or older than the steam-turbine itself. Still, its general acceptance as correct engineering practice had occurred only within the last five years.

At the present time the use of the turbine-pump had become so extended that it was difficult to find work to which it could not be applied advantageously. It would no doubt be a matter of interest to trace the evolution and development of machines of this design, and the authors, therefore, gave the history of such apparatus from the beginning of the 18th century.

Modern Practice.—The mechanical construction of a standard Mather - Reynolds pump as built in 1895 consisted of four chambers working in series. At the one end these were secured by bolts against the circular flange of a frame carrying the driving pulley or shaft coupling, this having the suction branch and entrance to the first chamber cast with it. At the other end the delivery chamber formed the final cover, and had the delivery pipe cast on the upper part connecting to the annular space into which the last set of guide-passages delivered, and at this end a suitable stay was attached to support the pump from the floor. The chambers were secured to each other by bolts through external flanges, each chamber being recessed and spigoted so as to preserve correct alignment of the whole. This formed an inexpensive design and permitted accurate manufacture. In comparing such a pump with a modern one it would be found that it was in the form of its impeller and its delivery-casing that the original Mather-Reynolds pump differed most from the present design. The impeller was of the open type, with radial vanes, the roots of which were carried across the openings of the eye into the boss, necessitating the use of a modified form of Francis entrance. This form was probably adopted in order to secure sufficient strength to drive the vanes, necessitating them being carried through full width to the boss on the pump-shaft, and not starting level with the outer diameter of the eye as at present. The impeller was turned all over, and revolved a close fit in its casing, which was turned to a corresponding form. This prevented leakage and loss of efficiency by the return of the water from the tip to the suction along the impeller sides.

A considerable number of pumps of the 1895 form were constructed for installations in this country and abroad, and Messrs. Sulzer Brothers, of Winterthur, who began the manufacture of multiple turbine pumps about the year 1896, evolved various modifications in the Osborne Reynolds design, whereby both the efficiency and the lifting capacity were considerably improved. They established in 1898 an interesting and novel installation of these improved pumps at the Spanish mines of Horcajo, which attracted considerable attention. Two years later an agreement was concluded between Messrs. Sulzer Brothers and Messrs. Mather and Platt which provided for an interchange of future improvements, and due acknowledgment of the original work of Professor Osborne Reynolds and of the improvements made by the two manufacturing firms.

A comparison of a four-chamber pump of the Sulzer design with the 1895 design showed three important differences. First, the body casting of the pump was constructed in one piece, with the intermediate pieces, guide-vanes, and impellers put in from one end.. Secondly, the impellers were shrouded and had backward-curved vanes; and, thirdly, the impellers were arranged back to back to compensate for the increased lateral end-pressure set up by the higher heads worked against. This arrangement of the impellers involved the use of somewhat tortuous passages in the pump to bring the discharge of the first impeller to the eye of the second, and so on. Moreover, these passages passing several joints increased the probability of internal leakage from one stage to another. The agreement between Messrs. Sulzer Brothers and Messrs. Mather and Platt came to an end by mutual consent in 1904, and after that date each firm further developed their pumps on their own lines.

Proceeding to discuss later designs of four-chamber pump, the authors showed that constructionally this pump differed principally in that the extended suction-end was shortened and was similar to the delivery-end. This enabled various classes of drives—motor, belt, or steam-turbine—to be better negotiated with a standard pattern. Successive chambers, instead of being secured to their neighbors by bolts and flanges, were held together by long bolts extending the entire length of the pump body and held only at the two ends (suction and delivery).

The impeller was of the shrouded type, having vanes bent well backwards and the guide-passages longer and more correctly divergent, whilst the return way to the eye of the next impeller was of a curved form and more in line and continuous with the receptive ports, thus preventing the abrupt right angle turn through the casing obtaining in the Reynolds pump. The losses in the Reynolds impeller through side friction in its casing were obviated, and any leakage from the periphery back to the suction was prevented or greatly minimized by the outer circumference of the impeller eye running in neck bushes with a very small radial clearance, amounting to less than 0.005 in. The importance of preventing this leakage was very great if high efficiency was to be secured. The impeller was turned all over outside to reduce loss by skin friction, and with the same object it was usual to use as many wheels as the circumstances would otherwise allow. The end or axial balance of the impellers was obtained by an automatic device, which acted well in practice, and compensated for wear and variable leakage taking place in the pump. In other respects the arrangement, direction or flow of water, and assemblage of the pump were the same as in the original Mather-Reynolds pump.

The authors concluded the paper with some examples of the application of turbine pumps for various purposes.

Experiments with the centrally hung lamps which have been carried out in Cheapside, King William Street, and Cannon Street, have been so successful that a scheme has been prepared by the Streets Committee to adopt this system of lighting in all the streets of the city of London. Under the scheme the lighting of the city will be divided almost equally between gas and electricity. The illumination will be increased from 668,405 candle-power to 1,270,160 candle-power, whilst it is claimed there will be an annual saving of $33,200.

SPECIFICATIONS.*

By Fred. S. Sells.

The author stated that in his view the accepted commercial meaning of the word "specification" was the written, printed, or "understood" construction of an article, piece of plant, or works, or the enumeration of the detailed requirements for the execution of a certain performance. In Germany, France, and America a specification as a rule was identical with standard practice, and in this country the want of standards and of recognized and acknowledged authorities was a great drawback. If those who were engaged in the carrying out of specifications had grievances against those who drew them up it must be admitted that the specifying engineer was heavily handicapped by the absence of standards, and that he must at times guard against the introduction of something which had never been tried, or with which he was not sufficiently familiar. On the other hand, where "standards" had been set up during the last few years they had not been accepted unquestioningly by the profession, and therefore the manufacturers had to be cautious in adopting them.

The next grade of specification was that drawn up by a professional man for the purpose of obtaining tenders. Such a specification should contain a detailed enumeration of articles required, stating where and how they were to be fixed. Each article should be described by an accepted nomenclature which assumed the existence of printed, written, or catalogued descriptions for the benefit of the tenderer. Should these not be accessible, corresponding matter might be added to the specification. Once such a specification was issued no deviation should be permitted unless it was clearly added from the outset that apparatus of similar construction, design, or capacity would be accepted.

The Consulting Engineer.—It was the endeavor of consulting engineers to advise their clients to have the most up-to-date, the most economical, and the best manufactured plant, but, unfortunately, the number of interpretations of these desiderata was almost equal to the number of consulting engineers in practice. Why? Not because the engineers were incompetent; not because they had not each of them wide and valuable experience; not because they, or most of them, had not done similar work before; not because of the absence of standards, and perhaps because of the absence of some uniformity of education and experience. The trouble might also be partly due to the aloofness of the average consultant from the work-shops of the manufacturer, and he felt certain that a closer and more regular intercourse between the manufacturer and consultant would result in benefit to both purchaser and contractor. The majority of manufacturers now gladly threw open their works to consultants at all times.

As technical knowledge and experience had developed during the last 25 years, so had the standard of commercial honor and integrity, and he did not think it either right or necessary that specifications should contain anything which was originally meant to prevent dishonesty, by which he meant the intention of not carrying out a specification as it was meant to be carried out, the use of insufficient material, flimsy construction, disregard of proportion, and the introduction of makeshifts leading to unsightliness. A large number of leading consulting engineers had already adopted broader-minded methods, but this course had not yet become general practice.

Would it not be better if consulting engineers, instead of drawing up specifications, each of which was a masterpiece of originality, were to adopt standards where standards were in existence; to accept standard practice where standard practice was established; and to ask the manufacturers in their specifications to put forward their own suggestions? Their work would then consist of going through all the various manufacturers' recommendations and suggestions, and of deciding which was the best designed and most serviceable plant at the prices submitted.

Municipal Engineers.—With reference to municipal and supply company engineers, the circumstances were in many cases the same as with consultants. The great difference lay in the fact that the municipal engineer had more frequently to be prepared for the acceptance of the lowest tender, without having the same opportunity as the consulting engineer to explain the difference in the offers; and as long as municipalities were governed as at present their engineers would not, as far as "detail" was concerned, be able to alter the present practice in this respect. The municipal engineer was even more a specialist in his particular work than the independent consultant, and in many cases he had more experience of what was actually required than the manufacturer. Especially where large stations were concerned his experience was valuable, and, if fully expressed in his specifications, it would help the manufacturer. Would it be possible through the medium of the existing organizations of municipal engineers to arrive at something like standard practice? It had been done in other countries, and had been done successfully.

Large corporations who had big laboratories with elaborate testing apparatus and a highly trained expert in charge had, of course, no difficulty in making fair and reasonable tests, but it was regrettable to find what tests were being made in some central stations in order to determine the candle-power of incandescent lamps and carbons, and what tests were sometimes applied to determine their life. They forgot that the products of the leading manufacturers were made to comply with the standards established by authorities such as the Engineering Standards Committee, the Admiralty, Post Office, large railway companies, and others.

* Abstract of paper delivered before the Institution of Electrical Engineers, Manchester local section.

PROVINCIAL POPULATIONS.

A special report of the census presented to Parliament gives the population by provinces as follows:

Province.	1911.	1901.	Inc.
Alberta	374,663	73,622	301,691
British Columbia	302,980	178,657	213,823
Manitoba	455,614	255,211	200,403
New Brunswick	351,889	331,120	20,769
Nova Scotia	492,338	459,574	32,764
Ontario	2,523,208	2,182,947	380,261
Prince Edward Island	93,728	103,259	*9,531
Quebec	2,002,712	1,648,898	353,834
Saskatchewan	492,432	91,279	401,153
Yukon	8,512	27,219	*18,707
N. W. Territories	16,951	20,129	*3,178
Totals	7,204,527	5,371,315	1,833,212

* Decrease. Total decrease 31,416

The rural population is 3,924,083, and the urban 3,280,441. The increase in rural population is 555,065 or 16.48 per cent., and in the urban 1,278,147 or 63.83 per cent.

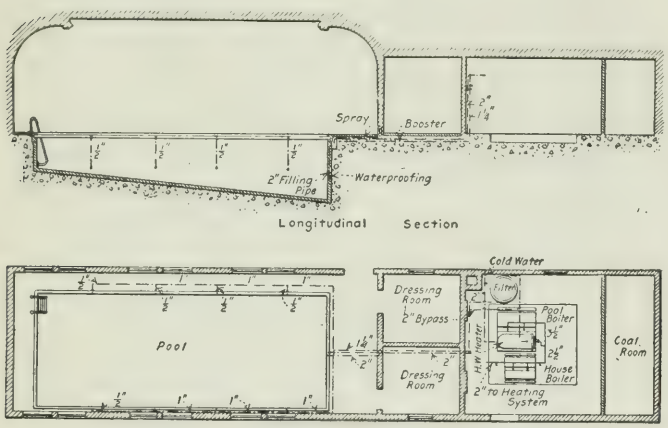
HEATING A SWIMMING POOL.*

By C. Teran.

A swimming pool is generally a luxury, not a necessity. For this reason not many are built, and a description of the system installed for Herbert Coppell at Tenafly, N.J., may prove of interest.

It is housed in a building of one story, and includes the pool room, two dressing rooms, boiler and coal rooms, all on the ground level. The pool is sunk below grade, is built of concrete, waterproofed and lined with English size enameled brick. It is 38 ft. long, 15½ ft. wide and 6 ft. mean depth below water level. The cubical contents are, therefore, 3,534 cu. ft.

The heating plant was designed to heat this volume of water in 10 hours, or at the rate of 353 cu. ft. an hour. Ten hours is a convenient length of time for heating the water, because the required apparatus is not specially large. If the apparatus was much smaller it would, of course, require a longer time to heat the water, and this time added to that necessary to empty and clean the pool would make the period of time which the pool would be out of commission too long. The time required to empty and clean this pool is 4 to 5 hours.



Plan.

The installation includes two cast-iron sectional boilers, a Berryman service heater and a filter. The water is reduced to 30 lb. pressure on entering the building. It is then heated in the Berryman heater by steam generated in the boilers, and then filtered and discharged into the pool. For filling, a main inlet is used; this enters the pool at the deep end near the bottom; there is also a nozzle above the water line which is used to produce a spray over the pool.

On account of the proximity of the walls of the pool to the outside ground a loss of heat in the water was anticipated and provision made to replace the loss. Careful consideration was given to the various methods that could be used to accomplish this purpose, and injecting water heated to a high temperature into the filled pool was decided upon. The reason for using a high temperature is that the water is not taken from the pool to be reheated, as this would necessitate a circulating pump, but fresh water is used, and by heating it to a high temperature a minimum quantity of water is required and less coal burned. The water is injected at four points on each side of the pool near the bottom, through nozzles passing through the brick lining and flush with it. This arrangement gives a good distribution, and is neat in appearance. It is found that during the winter months the water loses 2 to 3 deg. F. in 24 hours.

In filling the pool the water is heated to 75 deg. F., which, on account of heat losses in transit, etc., gives an ultimate temperature of 70 deg. F. The water injected to make up the heat loss is heated to 180 deg. F.

The large boiler is used to heat the water when the pool is being filled. This was computed as follows:

Contents of pool .....3534 cu. ft.
Water to be heated per hour.....353 × 62.4 = 22,027 lb.
Water to be heated per hour.....353 cu. ft.
Rise of temperature of the water.....40 to 75 = 35 deg.
Heat units transmitted to water per hour, 22,062 × 35.....771,000 b.t.u.
Coal necessary to be burned per hour 771 ÷ 8000.....96 lb.
Grate area, 96 ÷ 8 = ...12 sq. ft.

A boiler having a grate 40 in. wide by 48 in. long was installed. The other boiler shown is used to heat the building and the water injected into the pool to make up the daily loss of heat; by this arrangement, the necessity of keeping a fire in the large boiler is avoided. As there was no sure method of predetermining the loss of heat of the water in the pool, in selecting this boiler liberal allowance was made for this purpose above what is required to heat the building. The amount of direct radiation is 400 sq. ft., all behind screens; the boiler is rated at 1,000 sq. ft. and has a grate 21 × 27 in. or about 4 sq. ft.

The service heater was specified of proper size to heat 2,800 gal. of water per hour from 40 to 80 deg. F. with low-pressure steam, and it was left to the manufacturers who furnished it to design the proper size heater for this duty. The filter was specified in a similar manner. No automatic temperature control was installed, and none has been found necessary. An even temperature of the water is attained by maintaining a steady fire and regulating the flow of water by hand.

* A paper read before the American Society of Heating and Ventilating Engineers, New York City, Jan. 25th, 1912.

THE BRITISH ALL-RED WIRELESS TRANSMISSION SCHEME.

The proposal to connect all portions of the British Empire with wireless communication systems has at last taken definite form. A chain of 25 stations throughout the Empire are to be equipped with high power Marconi apparatus; the whole to be under the control of the General Post Office. The cost of construction is estimated at $6,000,000.00 and the yearly maintenance is placed at $1,000,000.00. The estimated revenue, according to predictions, will total $3,000,000.00 per year; considering 15,000 words a fair and conservative estimate to be transmitted from each and every station in the belt.

There is no other world power able to thus link up their overseas dominions, except Great Britain, as the lands of this empire lie in a continuous chain around the earth and sufficiently close together to overcome the problem of long transmission over water. There is one great advantage in this means of empire communication over the cable method, and that is the ability to reach and communicate with every ship on the seas properly equipped.

The stations are to be erected at Victoria, B.C.; Montreal, P.Q.; Glace Bay, N.S.; Jamaica, Barbados and other points in the West Indies; Bermuda; London, England; Bathurst and Sierra Leone, British West Africa; St. Helena, Capetown, Durban, Moneasa and Aden on the east coast of Africa; Mauritius; Cyprus; Malta; Bombay; Colombo; Adelaide; Singapore, and Hong Kong.

INDUSTRIAL ACCIDENTS IN JANUARY.

Industrial accidents occurring to 300 individual work people in Canada during the month of January, 1912, were recorded by the Department of Labor. Of these, 86 were fatal and 214 resulted in serious injuries. In addition 2 fatal accidents were reported as having taken place prior to the beginning of the month, information not having been received by the Department before January, 1912.

In the preceding month there were 84 fatal and 194 non-fatal accidents recorded, a total of 276, and in January, 1911, there were 91 fatal and 206 non-fatal accidents, a total of 297. The number of fatal accidents recorded in January, 1912, was, therefore 2 more than in the preceding month and 5 less than in January, 1911. The number of non-fatal accidents recorded in January, 1912, was 20 more than in the preceding month and 8 more than in January, 1911. Altogether there were 22 more industrial accidents recorded in January, 1912, than in the preceding month and 3 more than in the same month of the preceding year.

The following is a record of the accidents of the month by industries and groups of trades:—

Trade or Industry	Killed	Injured	Total
Agriculture	7	9	16
Fishing and hunting	2	..	2
Lumbering	4	7	11
Mining	14	15	29
Railway construction	9	12	21
Building trades	5	15	20
Metal trades	7	44	51
Woodworking trades	1	16	17
Printing and allied trades	..	..	..
Clothing	..	2	2
Textiles	..	1	1
Food and tobacco preparation	..	3	3
Leather	..	..	..
Transportation—			
Steam railway service	23	33	56
Electric railway service	..	8	8
Navigation	1	5	6
Miscellaneous	3	9	12
Public employees	1	13	14
Miscellaneous skilled trades	4	15	19
Unskilled labor	5	7	12
Total	86	214	300

ONTARIO'S PEAT BOGS.

It is announced by the Dominion Mines Branch that the associated manufacturers at Brantford, Ont., have become so convinced that the air-dried peat method employed by the mines branch can be made a commercial success that they have contracted with the government to continue the work at Alfred, Ont., and will spend over $50,000 in trying to improve peat machines. This action was decided on only after a thorough investigation. The machine to be used will have a capacity of 60 to 80 tons per day, as compared with the 30 tons the government turned out.

The government experimental plant at Alfred exhibited samples of machinery and of peat ready for market at the Ottawa fair. A thousand tons of peat were made up, which was sold at $3.25 a ton. The orders came with such a rush that the supply was soon exhausted. The peat was used in parlor grates, in kitchen ranges, and in furnaces. It burns to a fine ash, there being practically no residue, and is much cheaper than coal.

A NEW TUG FOR THE CITY OF TORONTO.

The city have under construction at the Polson Iron Works, a new steel tug to be used in the various engineering works projected and under construction about the city's water-front. There are several points about the vessel which have a tendency to make it unique in many particulars.

The material of construction in the hull is the best quality of Siemens-Martin open hearth mild steel; near the bow the material has been laid in such thickness as will permit the ship to be employed for ice breaking purposes when so required.

The propelling mechanism consists of a six-foot screw and a single cylinder high-pressure type, non-condensing engine. The diameter of the cylinder is sixteen inches and the length of stroke eighteen inches.

The boiler is of the Scotch cylindrical type, seven and a half feet long, and containing one hundred and fifty-two three-inch tubes; it has been built to pass government inspection for a working pressure of 150 pounds per square inch.

The illustration was made by the photographer a few hours previous to the launching, which took place on 8th March last. Before the hull could take the water a crew of twenty-two men and one horse worked for several hours to clear a space in the ice covering the bay, which, at this point, was almost thirty inches thick.

The draught of the vessel is six and a half feet when the bunkers are half filled with coal. The length is 70 feet, extreme beam 18 feet, and the depth at side (lowest point) 9 feet.

Mr. W. E. Redway, of the Polson Iron Works, is the designer and supervisor of the work on the tug, which has been named the "G. R. Geary." It is expected that it will be completed and ready for work about April 6th.

BUILDING FIGURES FOR SASKATOON.

In The Canadian Engineer, issue of February 29th, the building figures in twenty selected cities and towns throughout Canada were given. We have just received a letter from the city of Saskatoon, Sask., drawing to our attention the fact that figures for that city are not quoted, although "lots of other towns much smaller than this city are given."

We are very glad to remedy this omission. The following are the building figures for the months of January and February for 1911 and 1912 for the city of Saskatoon:

	1911.	1912.
January	$13,500.00	$13,800.00
February	9,950.00	69,700.00

Metallurgical Comment

T. R. LOUDON, B.A.Sc.

Correspondence and Discussion Invited

THE IMPROVEMENT OF RAIL DESIGN AND SPECIFICATIONS.*

W. C. Cushing.

The period between 1893, the year of the adoption of the standard rail sections of the American Society of Civil Engineers, and the first annual convention of the American Railway Engineering and Maintenance of Way Association in 1900, was occupied by the railway engineers in the study of the behavior in the track of the rails rolled, according to the new designs, which were rapidly put into service by the different railways of the country.

A preliminary meeting of the railway engineers was held in Chicago on October 21, 1898, for the purpose of organizing the American Railway Engineering and Maintenance of Way Association, and at that meeting a committee was appointed to draft the constitution and by-laws.

On March 30, 1899, the permanent organization of the association was effected in Buffalo, by the adoption of the constitution and the election of officers.

As stated in the constitution, the object of the association was the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railways. The real and final object was, however, for the members to exchange information and experience with each other and to bring about the unification, as much as possible, of specifications for the purchase of the large amount of material and supplies used by railways, which ought to result in the mutual benefit of the manufacturers and the railway companies.

In order to hear the first reports of standing committees, the first convention was held in March, 1900, in Chicago, and among the standing committees was one on rail.

The report of the committee was largely historical, but it was developed at that and subsequent meetings that the subject was going to be one of the most important and most interesting of those to come before the association in the future.

The work of the committee of the American Society of Civil Engineers was undertaken with the object of improving the design or cross-section of rails, and did not undertake the preparation of specifications for their manufacture or inspection, but each railway issued its own specifications, which were not specifications for manufacture, but for inspection. These specifications differed from each other in various details, such at the method of testing, the allowable variations from the templates, the smoothness of the surface and the workmanship generally, while but little was said about the chemical composition. Indeed, this state of affairs must have been quite annoying and expensive to the rail manufacturers, and, as all railways were striving for exactly the same object, viz.: to obtain the best material which would make an absolutely safe steel rail, the unification of the specifications seemed to be very desirable, and if it could be brought about, the existence of the association would be entirely justified.

At the annual convention in 1901 it was ascertained that the rail sections or designs of the American Society of Civil Engineers were in use by about 70 per cent. of the railways of the country, and it soon developed in the discussion that the rail steel in use by the railways was not giving very good satisfaction. This dissatisfaction pertained to all sections of rails, and the railway engineers thought that the trouble was largely due to the temperature of rolling being entirely too high, leading to the expression of one member that "the material was squirted through the rolls." The engineers of the rail manufacturers, who were also members of the association, contended, on the other hand, that the fault was due to the rail sections, and especially to the thin base designs of the American Society of Civil Engineers. It thus developed that the railway engineers believed the trouble was entirely due to improper processes of manufacture while the rail manufacturers' engineers placed the fault on the design of the rail cross-sections.

It was apparent, therefore, that the committee must study both the question of design and the question of rail manufacture, the latter with the special object of devising tests and methods of inspection which would more surely determine whether the material came up to the requirements of service or not. It was quite evident that this work would be of long duration, because it was necessary that more study than ever before should be placed upon both the question of rail design and its manufacture, and it would be necessary to proceed slowly and carefully, in order to avoid the misinterpretation of statistics and information. Sir Lowthian Bell is reported to have said, at the London meeting of the American Society of Civil Engineers, in 1900, that "as he had been 25 years a manufacturer of rails and 25 years a director in the North Eastern Railway, he represented both maker and user, and he had at his disposal 35,000 analyses to go upon in making deductions. From these he could prove and disprove everything that could be said for or against any composition of a rail—a facility beloved by the expert." It is well for any investigator not to forget Sir Lowthian Bell's remark. It has been brought home to the rail committee many times in its prolonged investigation.

Prior to this time, so much has been said by railway engineers about the necessity for rolling at lower temperature that, in 1900, the Kennedy-Morrison process of holding rails just before the final passes until they came to the desired temperature, after which they were put through the final passes at that temperature, was introduced by the Carnegie Steel Company, and great expectations of the value of the results were held. At the same time other rail manufacturers began rolling at lower temperature and claimed to accomplish the same results. The process did not, however, give the results expected, as the effect was only skin deep, for when the skin wore off, the ordinary metal was exposed underneath. The rails rolled after its introduction developed rather more failures than usual, and since that time the value of rolling at low temperature has been rather uncertain. This experience is mentioned to show that the value of many changes in process of manufacture can only be developed after long experience, which is one of the reasons why an investigation of this kind is bound to cover a long period of time.

In 1895, at Zurich, Switzerland, the International Association for Testing Materials was organized to bring about "the development and unification of standard methods of testing, for the determination of the properties of materials of construction, and of other materials, and also the perfection of apparatus for that purpose." On June 16, 1898, or but a few months prior to the organization of the American Railway Engineering and Maintenance of Way Association, there was formed, at Philadelphia, the American section of

* Presented at the Indiana Railroad Commission's hearing on the rail question at Indianapolis.

the International Association, which, a few years later, was renamed The American Society for Testing Materials. The American section was composed of manufacturers as well as of consulting engineers, railway engineers and others, and had already begun the study of rail specifications. Therefore, at its annual convention in 1901, the rail committee of the American Railway Engineering Association submitted the rail specifications recommended by the American branch of the International Association for discussion, in order to get the subject under way.

Specifications for steel rails have always consisted of three general parts:

1. Chemical requirements or properties;
2. Physical requirements; and
3. Details of manufacture.

Up to that time the various railways emphasized one or more of these parts, according to their individual preference or experience. Some almost ignored the chemical requirements, others were more or less elaborate in their physical requirements, while some barely touched upon details of manufacture, and others treated the subject quite elaborately.

1. The chemical properties of those proposed specifications for bessemer steel rails were those of the Carnegie Steel Company, and they are to-day the standard chemical specifications of all the steel rail manufacturers, and of the American Society for Testing Materials, with scarcely any alterations. They were as follows:

	50-60 lbs.	60-70 lbs.	70-80 lbs.	80-90 lbs.	90-100 lbs.
Carbon	.35 to .45	.38 to .48	.40 to .50	.43 to .53	.45 to .55
Phosphorus, not over	.10	.10	.10	.10	.10
Silicon, not over	.20	.20	.20	.20	.20
Manganese	.70-1.00	.70-1.00	.75-1.05	.80-1.10	.80-1.10

The specifications for foreign use were practically the same.

The only changes which have been made in these specifications by the steel manufacturers and by the American Society for Testing Materials up to the present time, are to make the carbon for 60 to 70-lb. rail .35 to .45, and the manganese for 90 to 100-lb. rail .84 to 1.14.

With few exceptions, the railways of the United States have accepted these chemical constituents as recommended by the rail manufacturers, because they have considered that the chemical properties were only a minor part of the specifications for rail steel, compared with the physical requirements.

To show that the railway engineers have been justified in taking this view of the matter, the following quotation is made from an article in the Journal of the Franklin Institute by Captain R. W. Hunt, once a manufacturer of steel rails and now a steel rail inspector of wide experience:

"Rails made by John Brown & Co., of England, and put down on American railways some years ago, have been generally held up as ideal rails, and the American makers for a long time supposed that when these rails did wear out so that they could be analyzed the secret of their good service would be told. As an illustration of how little regularity or purity of chemcal composition influenced the wear, I call your attention to the analyses of thirteen of the John Brown rails, all of which had filled years of faithful service and have been selected as bright examples of what good rails should be,

	C.	Si.	Ph.	S.	Mn.	Cu.
1	0.35	0.08	0.128	0.068	0.742	0.048
2	0.30	0.071	0.156	0.155	0.662	0.32
3	0.36	0.103	0.125	0.060	0.815	Trace
4	0 70	0.306	0.111	0.008	0.681	0.016
5	0.36	0.069	0.153	0.131	0.621	0.043
6	0.44	0.208	0 098	0.059	1.046	None
7	0.45	0.102	0.128	0.105	0.616	0.056
8	0.36	0.087	0.148	0 181	0.625	None
9	0.24	0.068	0.131	0.104	0.645	0.033
10	0.37	0.051	0.096	0.050	0.639	Trace
11	0.32	0.089	0.145	0.077	0.745	Trace
12	0.35	0.069	0.077	0.099	0.945	None
13	0.28	0.032	0.084	0.053	0.312	None

"You will observe that carbon ranged from 0.24 to 0.70; silicon from 0.032 to 0.306; phosphorus from 0.077 to 0.156; sulphur from 0.050 to 0.155, and manganese from 0.312 to 1.046.

"These 13 rails, taken as a whole, were chemically a 'poor lot,' but physically, most excellent."

2. Two general methods for testing the physical requirements had been in use up to the year 1900, viz., a bending test of a small bar ½ in. to ¾ in. square and 10 in. to 20 in. long, and a drop test, which consisted in letting fall a weight of about 2,000 lbs. on a piece of rail with a span of 3 to 4 ft. Some railways used one method, some the other, and some both, but by 1900 the small bar test had been generally abandoned in favor of the drop test.

It was customary to make a test of every fifth heat of steel, and to let the weight fall from varying heights, according to the pleasure of the maker of the specifications. The proposed specfications of the American branch retained this method of testing the physical properties by dropping the weight of 2,000 lbs. on every fifth heat of steel, from a height of 16 ft. for rail weighing 55 to 65 lbs. per yard, 17 ft. for rail weighing 65 to 75 lbs. per yard, 18 ft. for rail weighing 75 to 85 lbs. per yard, and 19 ft. for rail weighing 85 to 100 lbs. per yard, but these conditions were not accepted by the American Railway Engineering Association, as there was a strong feeling among the railway engineers that more severe conditions of testing were necessary. They felt that the chemical properties could be left to the greater experience and chemical knowledge of the rail manufacturers, but that they must be the ones to prescribe the physical tests which the finished rails must stand in order to be accepted for such important service as carrying the railway traffic of the country. In 1904, therefore, the engineering association decided that each heat, instead of every fifth heat of steel, must be tested, and that the height of the drop should be increased.

It was also ascertained that the rail butts heretofore tested under the falling weight had been from the bottom of the ingot, and it was now made a part of the specifications that the test piece should be taken from the top of the ingot, on account of the probability that the metal would be less perfect at that end.

Testing every heat instead of every fifth heat, as formerly, was considered little short of a revolution in the method of testing at that time.

3. Except in the case of a few companies, the specifications in regard to details of manufacture were not elaborate, being confined almost entirely to allowing for variations from the standard template and from the length of the rail, to smoothness and perfection of finish, to branding, etc.

In view of the agitation for colder rolling, the Pennsylvania Railroad had introduced into its specifications, in 1900, a clause requiring that the rail at the last pass should be at a red heat, preferably a dull red, but in 1901 they replaced it with the so-called "shrinkage clause," which was intended to control the temperature of the rail when being finished, by prescribing that the shrinkage, after the rail was sawed, should not exceed a certain number of inches. This clause was also introduced into the proposed specifications of the American Railway Engineering Association, making an additional requirement in the details of manufacture.

Lately there has been a great deal of argument on the part of the rail manufacturers to have the railway engineers specify a definite percentage of discard from the ingot, in

order to cut off material which is more subject to segregation and more liable to have interior defects from the shrinkage cavity, gas bubbles, etc., but the railway engineers have rigidly set their faces against such a requirement, because they feel that they are much better safeguarded by the clause introduced into the specifications of the American branch of the International Association for Testing Materials, which was that "sufficient material should be discarded from the top of the ingots to insure sound rails."

When that clause was adopted, in 1901, and for a number of years afterwards, the positions of the rail manufacturers and the railway engineers were reversed, the railway engineers believing that it was best to specify a definite amount of discard, while the rail manufacturers took the opposite view. It was well expressed by an engineer of one of the steel companies, who said: "I do not think this association, nor any other should state definitely how much should be sheared from the bloom. The matter is entirely one-sided. If we agree here that 25 per cent. shall be sheared from the bloom, we might assume that would settle it, but it will not. The association will be perfectly safe in making the claim that sufficient shearing will be done to eliminate piping. If the manufacturers can remove the piping by shearing 15 per cent., they will not agree to shear 25 per cent. The object in shearing is to get rid of the piping, and the only matter of agreement will be to reach the point where sufficient shearing is done to remove the piping. For that reason, I think the association will make a mistake to demand that 25 per cent. be sheared off."

The railway engineers of to-day unanimously agree with that point of view, and their position has been further strengthened by an additional test, which will be described later. Furthermore, the records of rail failures which have been kept for a number of years disclose the incontrovertible fact that, where a 15 per cent. discard might do for one ingot, 50 per cent. would not be adequate for another.

In 1902 the American Society of Civil Engineers deemed it advisable, in view of the continual criticism of the sections of rail which they had previously designed, to take up once more the study, both of real design and specifications, and accordingly a committee was appointed for the purpose. The committee of the American Society for Testing Materials also continued its study of the rail question, and joint meetings of all three committees were held so that each would derive benefit from the work of the other.

On April 25, 1906, the committee on standard rail and wheel sections was appointed by the American Railway Association, and on October 24, 1906, the committee was directed to report in addition on the subject of specifications for the manufacture of steel rails, in connection with its report on standard sections. The rail manufacturers were asked to co-operate with the committee by sending representatives to study the question with it at its meetings, and in addition the committee employed disinterested men of national reputation for their knowledge of steel making and the properties of steel, to give expert advice on the subject. After many meetings together a report was submitted on October 30, 1907, containing the recommended rail sections and specifications, both for bessemer and open hearth steel.

Further advice was obtained from disinterested persons, who had a wide knowledge of the properties of steel and its manufacture, and a final report was submitted by the committee on April 22, 1908, with the recommendation that there were many details of the development and the following up of the results in service of the new types of sections, rolled under the new specifications, which would require considerable time and much careful study, and that they could be more efficiently and more appropriately handled by the American Railway Enginering Association. The sections and specifications were, therefore, referred to the American Railway Engineering Association, with the request that it follow up the question in its various details and keep a careful record of the results, with a view to determining whether any changes should be made, either in the specifications or designs.

As the question of discard was dealt with in these reports quite fully, it is advisable to make quotations therefrom, because the earnest consideration given to the question led to the development of an additional test, which is considered of great importance in determining the quality of metal by eliminating a large number of the so-called "piped rails," or rails with interior defects:

"In the matter of discard, there was a desire on the part of the railway members to arrange for a greater discard, and a strong disposition to insist upon a uniform minimum percentage. The manufacturers, however, presented considerable evidence which tended to show that a fixed minimum percentage requirement would be not only unfair but unscientific, claiming that the extent of piping and segregation is influenced by the size of the ingot, the rate of pouring into the mould and other details of mill practice.

With regard to the discard question, the committee has always been of the opinion that it would be preferable to test the finished product rather than specify as to details of mill manufacture.

"In pursuing its investigation of this discard question, the committee received a suggestion from William Metcalf to the effect that it would be reasonably practicable to apply the above theory to the manufacture of rails by arranging to test to destruction a number of rail butts representing a certain portion of the total output and to base rejections on the results of these tests.

"In order to avoid the unnecessary waste of good material, the committee set about to devise means by which the rejection of defective material could be insured without requiring an arbitrary and definite percentage of discard in every case, and a committee of the Pennsylvania Railroad, pursuing the same line of investigation, adopted a tentative specification which provided for a physical test of this nature, and which further provided that when physical defects were discovered all top rails of the heat should be rejected. This would result in a discard of about 25 per cent. to 30 per cent. of the entire metal in the heat whenever physical defects were discovered, and it was felt that a requirement of this nature would not only provide for the rejection of defective material, but would insure the greatest care on the part of the manufacturer.

"A trial lot of the rails of a section corresponding to type 'B' was recently rolled under these specifications as to discard, and the results convinced the committee that a development of this idea would prove the best solution of the discard problem."

In connection with the details of manufacture, an important addition was made by requiring that the brand on the rail should also contain a letter marking the position which the rail originally occupied in the ingot, so as to enable a study to be made of the effect of that position.

On June 5, 1907, a committee of civil and mechanical engineers of the Pennsylvania Railroad System and two rail manufacturers was appointed to take up the study of the rail question, and design new rail sections and recommend new specifications, with the object of improving the quality of material used in rails manufactured for that system.

The first meeting was held on June 12, 1907, and the new rail designs, known as "P.S." sections, were adopted on September 20, 1907. Tentative specifications were recommended on November 15, 1907, and 10,000 tons of rail

rolled in accordance therewith. The specifications were subsequently modified, on criticism of the manufacturers, and issued February 4, 1908.

The new rail designs of the Pennsylvania and the American Railway Association provided for a more even distribution of the metal in the head, web and base and for a thicker base, to meet the views of the rail manufacturers, who believed that a better distribution of the metal would result in an improved quality, due to more favorable rolling conditions. All of these sections are still in service and are being closely watched to determine whether the expected improvement will be realized.

The Pennsylvania Railroad System specifications have been modified several times, in the light of additional experience, and contain the improvements which have been brought about from time to time through the experiences and researches of its own committee and the committees of the other associations. So far as the chemical requirements are concerned, they are practically the same as adopted by the rail manufacturers, and the other associations. The physical requirements are determined by the drop test with the standard machine, and, in addition, the test piece is nicked and broken to reveal the presence or absence of interior defect. In the details of manufacture, the discard is required to be sufficient to secure sound rails, and the shrinkage clause to regulate the temperature of rolling is retained. The rails are marked for position in the ingot, for the purpose of subsequent identification, in order to study the effect of that position.

Similar studies and investigations are being conducted by the New York Central Lines, Harriman Lines, Baltimore & Ohio, Norfolk & Western, Lehigh Valley, Reading, and other companies, and the specifications are being improved as new knowledge is obtained. The first-named company has been foremost in the study of the effect of titanium in steel making.

Through the assignment of the rail question to the American Railway Engineering Association by the American Railway Association, the work of the committee was given official character, and its real work commenced. The first thing of importance accomplished was the introduction of a standard drop testing machine at all the rail mills, so that the results obtained at any one mill were comparable with those obtained at any other. Up to that time, 1908, machines of different design and setting were used, and the results were unreliable. With the year 1909 began the collection of a large amount of information, obtained from research work, bearing on the disputed points of rail manufacture and on proving or testing.

In 1910 the specifications for bessemer rail, formerly adopted by the American Railway Engineering Association, were withdrawn, and new ones, for both bessemer and open hearth, were presented for consideration by the association, which embodied all the improvements in the methods of determining the physical properties and the details of manufacture which had been brought forward up to that time. It was recognized, however, that numerous disputed points could only be cleared up by experimental research conducted by a trained engineer-physicist, and accordingly such an investigator was added to the committee to devote all his time to that work. The engineer of tests, M. H. Wickhorst, since his appointment, has been constantly busy with research work, and has added a great deal to our knowledge of the subject.

He has made reports on the following subjects: Influence of Carbon on Deflection; Drop, Bending and Tensile Tests on Bessemer, Titanium Bessemer, and Open-Hearth Rails; rolled by different mills, including chemical analyses and etched sections; Investigation of a Split Head Rail; Segregation, as influenced by Fire Clay on the Ingot; Strength of Rail Head; Drop Tests of Rails—Effect of Impact Energy variously Distributed; Flow of Rail Heads under Wheel Loads; Segregation and Other Rail Properties as influenced by size of Ingot; Tests of Steel Rail Ingots and derivative shapes made at Watertown Arsenal; Influence of Rolling Temperature on the Properties of Bessemer Rails.

In all of this work Mr. Wickhorst has been afforded every facility by the rail manufacturers for carrying on the investigations, and their machinery, material and laboratory assistants have been placed at his disposal. In addition, their officers have been freely consulted by the committee and have attended some of its meetings.

While at the present time the American Railway Engineering Association has not adopted standard specifications for rails, yet it has had constantly before it for consideration and study a set of proposed specifications which have embodied the best knowledge of the subject, and they have been changed from time to time in the light of new experimental investigation. The most energy has been devoted to the improvement of methods of testing to determine the physical properties, and practically no changes have been made in the chemical requirements from the standard specifications of the rail manufacturers. The railway engineers prefer to subject the finished material to such tests as will cast aside the defective rails. Their specifications, therefore, include many additional tests over those in use ten years ago. The results of the work of the American Railway Engineering association have been closely followed by the railway companies and vice versa, so that the specifications of the railways have been improved from time to time, and now embody the additional tests devised. Rails have been rolled in accordance with these new specifications for several years, and it is believed that a marked improvement is apparent in the rails being laid in the tracks since their adoption.

DETERIORATION OF COAL IN STORAGE.

The amount of deterioration of coal in storage has been determined by accurate tests made by the Bureau of Mines of the United States. The results of these tests are presented in a paper to the American Chemical Society by H. C. Porter and F. K. Ovitz.

Moisture, ash, sulphur and calorific value determinations were made on each sample, the last by means of the Mahler bomb calorimeter and a carefully calibrated Beckman thermometer. The calorimetric work on all except the Sheridan, Wyo., tests has been done throughout by one man, Mr. Ovitz, and with the same instrument. All the calorific values have been calculated to a comparable unit basis, viz., that of the actual coal substance free moisture, sulphur and corrected ash.

The results show in the case of the New River coal less than 1 per cent. loss of calorific value in one year by weathering in the open. There was practically no loss at all in the submerged samples and fresh water seemed to "preserve the virtues" of the coal as well as salt. There was almost no slacking of lump in the run-of-mine samples and the crushed coal in all cases deteriorated more rapidly than run-of-mine.

TITANIFEROUS IRON ORES.

Some 3,789 tons of titanic iron ore were shipped from the St. Urbain mines, Quebec, during 1911. This ore is used as an ore of titanium, in the United States, in the manufacture of special rail steel, and also enters into the composition of special carbons for arc-lights.

BREAK IN LARGE WATER MAIN.

A thirty-six-inch water main caused considerable damage to property when it burst in Toronto on the morning of March 9th last. The cause of the rupture has not definitely been determined, but it is thought that water hammer is responsible for the damage. The flowing water quickly flooded many cellars in the vicinity and necessitated a call

View Showing Flooding of Street Before Water was Shut Off.

being sent in for the steam fire pumps to remove the water from the damaged basements.

The break occurred at 11.30 a.m. and was flowing for about one hour, with the loss of about 1,000,000 gallons of water. The break was repaired by 8.30 a.m. March 11th, the total length of time the main was out of commission being less than 45 hours.

PROVINCIAL BOUNDARY EXTENSIONS.

The boundary extensions of Quebec, Ontario and Manitoba were discussed in the House at Ottawa this week. The government proposes that Ontario shall have a five-mile wide strip from the proposed boundary to the Nelson River; a frontage of ten miles along the east bank of the river for terminals, docks and elevators; a two-hundred-foot right-of-

way to the Hudson Bay Railway to connect with Fort Churchill; and exemption from taxes on land in Manitoba.

The boundaries of Manitoba and Quebec will also be extended. The subsidies to which Manitoba would be entitled apart from the present arrangement, on July 1st, 1912, would total for the year $883,438. This compared with the Alberta subsidy of $1,260,105 and Saskatchewan $1,551,820.

The present area of the provinces are about as follows:

	Square miles
Quebec	351,873
Ontario	260,860
Manitoba	73,732

The additional territory would represent (roughly) the following areas:

	Square miles
Quebec	355,000
Ontario	140,000
Manitoba	180,000

The accompanying sketch shows the new territory proposed to be added to the three provinces. Quebec gets Ungava, Ontario that share of Keewatin shown between dotted lines and Manitoba the territory to the north of her present boundary.

THE WRECK OF THE KNAPP ROLLER BOAT.

Our photographer, while engaged about his business near the water-front of Toronto, came upon the wreck of the old Knapp Roller boat frozen in the ice off the foot of Frederick Street. Our readers will remember the stir caused among engineers when the operating principle of this ship was first made public, about the year 1896, and the many prophecies and expectations that arose just previous to the launching and trial trip, which took place in the year 1897.

The wreck is little better than scrap now, the plating being wrenched off in places and almost entirely at one end. The method of operation whereby the ship was expected to move may be briefly stated thus: A large central drum was free to revolve within the outer casing. At the ends of the drum or tube, the propelling machinery was geared to the outer casing, which was furnished with blades in a manner similar to a paddle wheel of a ferry steamer. The trial trip was sufficient to show the impracticability of the project and the ship, instead of making about thirty knots, was unable to make efficient headway, even in a comparatively smooth expanse of water. Shortly afterwards the ship was abandoned, and now lies as depicted in the illustration. The wreck is in the direct path of the proposed government dock to be erected at the Polson Iron Works; and this will doubtless in the near future necessitate its removal. The experiment is reported to have cost about $15,000.

ENGINEERING NOTES.

Montreal, P.Q.—The Engineers' Club of this city are considering the building of an addition to their quarters on Beaver Hall Square. The improvements contemplated will increase the value of the property to $500,000.

Ottawa, Ont.—Hon. Col. Sam Hughes, at a dinner given to the Cavalry Association, stated that the time was coming when military engineers would lay out the public highways, national harbors, etc.

Hamilton, Ont.—A report states that the first macadam pavement to be used as a pavement in Ontario was laid in this municipality. It was placed in position in 1880 and is still in use in certain sections of the city.

Ottawa, Ont.—A delegation waited upon the federal government asking that body to subsidize a proposed tunnel to be built across the St. Lawrence River near Montreal. The tunnel would be used for steam and electric roads.

Great Britain.—Owing to the recent disastrous submarine accident there has been devised a new means of raising sunken vessels. In the operation of this a number of canvas bags are sunk and secured to the wreck by hawsers securely fastened by divers. Compressed air is then driven into the canvas bags or cylinders and the ship raised by means of the air.

Toronto, Ont.—The Board of Control have presented a report on the municipal hydro-electric system wherein they state that the work accomplished up to December 31st, 1911, included the completion of the Duncan Street sub-station building, the building of the high level station, the West Toronto station and the St. Lawrence Market station. The report states that the electrical work in the above mentioned stations is in a very advanced condition, in many cases being 80 and 90 per cent. completed. 198,228 feet of cable were drawn in; 1,251 joints were made; 228 joints were wrapped with asbestos, and 700 transformers were installed. 23,016 concrete and 7,986 wooden poles were erected and 2,151,511 pounds of wire strung.

Regina, Sask.—The municipal Fire, Light and Power Committee have prepared a new set of building laws for the city. The new laws provide that during street track construction no materials shall be deposited nearer than eight feet to the nearest rail; that no permit for sidewalk obstruction shall be valid for more than one week prior to the commencement of the excavation, nor shall the permit be valid for a period exceeding four months; it may, however, at the option of the committee, be renewed for a longer period. The concluding clauses dealing with the protection of the city from responsibility in case of accident and the penalty for non-observance of the by-law were rather indefinite in detail, and the by-law was referred back by the council to the city solicitor for alteration.

Mr. J. A. Brodie, of the Liverpool municipal engineering office, has been recommended by the Liverpool Health Committee to lay out the new capital of India.

PERSONAL.

Mr. L. W. Morden has been appointed sales engineer of the Packard Electric Company; his headquarters will be in Toronto.

Mr. C. C. Owens has recently been placed in charge of the Detroit District Sales Office of the Westinghouse Electric and Manufacturing Company, with the title of district manager.

Mr. E. R. Mathewson has been awarded the gold medal of the Institution of Mining and Metallurgy, London, England. Mr. Mathewson is the general manager of the Anaconda Smelting Works. He is a graduate of McGill University, Montreal, his native city.

Mr. H. E. Grant, sales agent in the light and power department of the B. C. E. R. Co., Vancouver, has been invited by the executive of the National Electric Light Association to read a paper on the education of central station employees at the approaching convention of the body in Seattle.

Mr. H. A. Whiting, of Bellingham, Wis., U.S.A., has been appointed construction engineer of Edmonds, British Columbia. He will have charge and be held responsible for all outside municipal work, while the work of planning new improvements and inspecting subdivision plans will be undertaken by the present engineer, W. A. McPherson.

Mr. Mieville, resident engineer of Messrs. W. H. Allen, Son & Company, of Bedford, Eng. (who are represented in Canada by Messrs. Chapman & Walker, of Toronto), has just left for an extensive tour of the West, and will call at all the leading towns en route.

OBITUARY.

The death is reported of **Mr. John S. Metcalf,** president of the John S. Metcalf Co., Ltd. His death occurred at his home in Evanston, Ill., on the evening of March 4th. Heart trouble and complications were the cause of death. Mr. Metcalf had devoted his life to the designing and construction of large grain elevators. Many of the largest elevators in Canada were his work. He was born near Sherbrooke, Que., in 1847. He leaves a wife and three daughters.

Mr. F. J. L. Tytler, civil engineer, of Vancouver, B.C., is dead in that city. His death was due to heart failure and occurred on Sunday, March 3rd, last. Mr. Tytler was born in India, his father being an officer in the British army. He came to Vancouver in 1890 and was for some time in the employ of the Provincial Government in the superintendence of dyking operations, principally in the Matsqui district. He was married a number of years ago to a sister of the late Captain Livingstone, of Hatzic, and leaves one child. Mr. Tytler was principal of the Technical School of Civil Engineering and Surveying.

MEETINGS.

Victoria, B.C.—The Road Superintendents' Conference was held in this city; Premier McBride and Hon. Thomas Taylor extended a welcome to the delegates. Mr. R. H. Thomson, chief engineer of the Seattle Port Commission, delivered an address in the course of which he stated that it was impossible to lay down any hard and fast rules for road construction. He showed how road engineering had advanced since the days of Telford and Macadam. He showed several lantern slides of roads in Europe to his audience. A number of municipal representatives were present, including Mayor Beckwith and several aldermen, City Engineer Smith and members of his department.

* * * *

A meeting of the Canadian Society of Civil Engineers was held at their rooms on Dorchester Street, Montreal, when considerable discussion was had on reports put in by committees appointed to draft standard specifications and classifications for railroad and road construction. Mr. J. M. Shanley presided over the meeting, and at the close refreshments were served.

* * * *

The fourteenth annual meeting of the Canadian Mining Institute was held in Toronto recently. The occasion was the cause of one hundred and eighty mining engineers and mining men concentrating and conversing on the mineral conditions of this country. Hon. W. H. Hearst, Ontario Minister of Lands, Forests and Mines, read the address of welcome to the delegation and then followed the reading and discussion of various papers. Among these papers were "Manganese and Tungsten Deposits in Nova Scotia," "Accident Prevention or the Conservation of Human Life," "Sanitary Conditions in Mining Camps."

The meetings terminated by a banquet, which was held during the evening of March 8th.

The elections resulted in Mr. G. G. S. Lindsey, K.C., being the new president.

LECTION OF DOMINION LAND SURVEYORS' ASSOCIATION.

At the annual meeting of the Dominion Land Surveyors' ssociation, held in Ottawa, March 6th, Mr. R. A. Belanger, Ottawa, was elected president. The other officers will : Vice-president, C. F. Miles, Toronto; secretary-easurer, E. M. Dennis, Department of the Interior, Ottawa; xecutive Committee, J. D. Craig, J. J. Steele, J. S. Nash, Ottawa; auditors. C. Engle, E. L. Burgess, Ottawa; cond vice-presidents, Ontario, C. F. Aylesworth, Ottawa; uebec, G. F. Lonergan, Buckingham; Manitoba, C. H. ayne, Winnipeg; Saskatchewan, R. H. Montgomery, Prince bert; Alberta, J. N. Wallace, Edmonton; British Columbia, F. Ross, Kamloops; Yukon, F. H. Kitto, Dawson.

TTAWA BRANCH CANADIAN SOCIETY CIVIL ENGINEERS.

An interesting lecture was delivered by Mr. A. A. Dion, perintendent of the Ottawa Electric Company, before the ttawa branch of the Canadian Society of Civil Engineers, March 6th. "The Choice of Current and Motors in ectrical Installations" was the subject. Mr. Dion lucidly scribed the properties of different currents, giving infor-ation of a most helpful kind for those who have to decide to what systems to use in installation of light or power. he lecture was illustrated by charts and apparatus.

COMING MEETINGS.

NATIONAL ASSOCIATION OF CEMENT USERS.—March, 11th-16th. nual Convention at Kansas City, Mo. Sec'y, Edward E. Krauss, Harrison dg., Philadelphia, Penn.

ALBERTA BUILDERS EXCHANGE.—Annual Convention to be held in thbridge, Alta., on March 16th, 1912. Business sessions will be brought to a se with a banquet.

CANADIAN INSTITUTE.—198 College Street, Toronto. Saturday Evening ctures, 8 p.m. March 16th,—"The Relative Blood Supply to the Various gans of the Body," by Prof. Brodie, Toronto University, March 23rd,—"Waste nd Problems,' by Dean Fernow, Toronto University.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street est, Montreal. President, W. F. TYE: Secretary. Professor C. H. McLeod.

ICTORIA BRANCH—Chairman, F. C. Gamble; Secretary-Treasurer, R. W. Macintyre

UEBEC BRANCH—Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at room 40, City Hall.

ORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

ANITOBA BRANCH—Secretary E. Brydone Jack. Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

ANCOUVER BRANCH—Chairman, Geo. H. Webster: Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department. University.

TTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, ayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. homas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red eer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford vans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., x-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, ouncillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready, City lerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. lacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor ec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor lanta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey entre, B.C.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
3-18	Concrete reservoir (2,000,000 gallons' capacity), Moose Jaw, Sask.....(P. & S.)	2-22
3-18	Centrifugal pumps, motors, etc., Moose Jaw, Sask. .....(P. & S.)	2-22
3-18	Valves and Fittings, Moose Jaw, Sask. .....(P. & S.)	2-22
3-18	96,000 ft. of 18-in. Steel Pipe, Moose Jaw, Sask. .....(S.)	2-22
-15	Pavements, Welland, Ont. .....(P. & S.)	2-29
3-25	Prime mover equipment, electric lighting equipment, etc., Moose Jaw, Sask.....(S.)	3-7

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Belleville, Ont., concrete mixer.	Mar. 13.	Feb. 7.	59
Calgary, Alta., boiler feed pump and switchboards ...	Mar. 15.	Feb. 29.	59
Calgary, Alta., sewer and conduit pipe	Mar. 14.	Feb. 29.	59
Calgary, Alta., designs for aqueduct	May 1.	Feb. 22.	70
Calgary, Alta., electric machinery	Mar. 20.	Feb. 8.	68
Carp, Ont., church	Mar. 21.	Feb. 7.	59
Cheticamp, N.S., dredging	Mar. 20.	Feb. 7.	60
Columbus, Ont., 12 reinforced concrete bridges	Mar. 18.	Feb. 7.	59
Edmonton, Alta., steel highway Bridges	Mar. 15.	Feb. 22.	59
Fredericton, N.B., concrete substructure and approaches to bridges	Apr. 1.	Feb. 29.	59
Fredericton, N.B., bridge at Stone Ridge	Mar. 18.	Feb. 7.	89
Fredericton, N.B., culvert, McKenzie Hollow	Apr. 3.	Feb. 7.	89
Fredericton, N.B., culvert, Pokiok Embankment	Mar. 25.	Feb. 7.	59
Green Point, N.B., breakwater.	Mar. 18.	Feb. 29.	60
High River, Alta., schoolhouse.	Mar. 15.	Feb. 29.	59
Lorneville, N.B., extension to breakwater	Apr. 1.	Feb. 7.	60
Merid, Sask., road grader and scrapers	Mar. 24.	Feb. 7.	60
Moose Jaw, Sask., reservoir ...	Mar. 18.	Feb. 22.	66
Moose Jaw, Sask., pumps, motors, etc.	Mar. 18.	Feb. 22.	66
Moose Jaw, Sask., turbo-generating set; generator	Mar. 30.	Feb. 7.	60
Moose Jaw, Sask., prime mover equipments, etc.	Mar. 29.	Feb. 7.	68
Moose Jaw, Sask., valves and fittings	Mar. 18.	Feb. 22.	66
Moose Jaw, Sask., laying steel water pipe	Mar. 18.	Feb. 22.	66
Point Grey, B.C., plans for University	July 21.	Feb. 7.	60
Prince Albert, Sask., sewer pipe.	Mar. 15.	Feb. 29.	68
Saskatoon, Sask., electrical equipment	Mar. 22.	Feb. 29.	68
Saskatoon, Sask., Portland Cement	Mar. 15.	Feb. 29.	70
Saskatoon, Sask., labor on storm sewers	Mar. 29.	Feb. 29.	72
Saskatoon, Sask., sewer and water construction	Mar. 29.	Feb. 29.	72
South Gloucester, Ont., brick veneer presbytery	Mar. 15.	Feb. 29.	60
St. Jerome, Que., hydro-electric installation		Feb. 7.	68
Toronto, Ont., electrical equipment	Mar. 26.	Feb. 7.	68
Toronto, Ont., work on T. & N.O. Rly.	Mar. 20.	Feb. 7.	60
Toronto, Ont., rails, ties and fastenings	Mar. 19.	Feb. 29.	68
Vancouver, B.C., water pipe ...	Mar. 20.	Feb. 29.	60
Welland, Ont., pavement	Mar. 18.	Feb. 29.	72
White Rock, B.C., quarantine station	Mar. 15.	Feb. 15.	59
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., cables	Mar. 25.	Feb. 15.	60

TENDERS.

Calgary, Alta.—Tenders will be received until March 25th, 1912, for the erection of a modern business block, 125 feet by 130 feet, three storeys high, in Medicine Hat. Plans, etc., at office of the architect, Mr. F. J. Lawson, Norman Block, Calgary.

Calgary, Alta.—Tenders will be received up to noon of April 15th, 1912, for the design, manufacture and erection complete on piers to be provided by the railway company, of steel highway bridges for the C.P.R. Company. Full instructions may be had on application to A. S. Dawson, Chief Engineer, C.P.R., Calgary, Alta. (See advt. in Can. Eng.)

Halifax, N.S.—Tenders will be received until March 27th, 1912, for the construction of a garbage incinerator and accessories complete in accordance with specifications on file at the City Engineer's office, where forms of tender, etc., may be obtained. J. J. Hopewell, Clerk of Works, City Works Office, Halifax, N.S.

Hamilton, Ont.—Tenders will be received by Mr. J. Wall, general manager of British Canadian Canners, Limited, Lister Block, Hamilton, Ont., for the several works required in the erection of canning factories, warehouses, etc., at Cobourg, Bowmanville, Port Robinson, Merlin and Highgate, Ont. Tenders close at noon, Saturday, March 23rd. Plans and specifications may be seen at the residence of the local manager at above places, at the company's offices at Hamilton, and at the offices of Munro and Mead, architects, Chancery Chambers, Hamilton.

Kerrisdale, B.C.—The corporation of the municipality of Point Grey invites tenders for the supply of pipes and all material and for the installation of a system of sewerage for Eburne district. Drawings, etc., may be seen at the office of the engineers, Messrs. Cleveland & Cameron, 506 Winch Building, Vancouver, B.C. Tenders to be received until March 18th, 1912. H. Floyd, clerk of municipal council, Municipal Hall, Kerrisdale, B.C.

Lethbridge, Alta.—Tenders will be received up to noon of Thursday, April 11th, 1912, for approx. 2½ miles of sanitary sewers; approx. 3½ miles of cement walks (curb and gutter in addition); approx. 7 miles of grading. Plans and specifications on file at the office of the City Engineer, A. C. D. Blanchard, also office of Canadian Engineer, Winnipeg. G. W. Robinson, Secretary-Treasurer. (See advt. in Can. Eng.)

Oakville, Ont.—Tenders will be received until April 1st, 1912, for the construction of main sewerage and sewage disposal works in the town of Oakville. Specifications may be obtained at the office of the engineer, T. Aird Murray, 303 Lumsden Building, Toronto. C. A. Bradbury, town clerk, Oakville, Ont. (See advertisement in Canadian Engineer.)

Ottawa, Ont.—The Dept. of Public Works invite tenders for the interior fittings to Post Office, Customs and Inland Revenue, Campbellton, N.B. Tenders to be received until March 18th, 1912. Plans, etc., at the office of Mr. John Quin, Clerk of Ways, Campbellton; D. H. Waterbury, Clerk of Works, St. John, N.B.; and office of R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until March 14th, 1912, for the purchase of the damaged machinery of dredge "New Brunswick," stored in the Custom House at St. John, N.B. Forms of tender can be obtained at the office of G. G. Scovil, Esq., Supt. of Dredges, Dept. of Public Works, St. John, N.B. R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the erection of a frame schoolhouse on the St. Mary's Indian Reserve near Fredericton, N.B., will be received up to noon of April 4, 1912. J. D. McLean, assistant deputy and secretary, Department of Indian Affairs, Otttawa.

Port Arthur, Ont.—Tenders for paving will be received until Monday, April 8th, 1912. Specifications, etc., may be obtained from L. M. Jones, city engineer, Port Arthur. J. McTeigue, city clerk, Corporation Offices, Port Arthur. (See advertisement in Canadian Engineer.)

Prince Albert, Sask.—Tenders will be received by C. O. Davidson, secretary-treasurer of this city, up to noon of Friday, March 29th, for the construction of sewers, sewage plants, and water mains and materials. (See details of tender in the advertising section of this issue.)

Saskatoon, Sask.—Tenders will be received until March 20th, 1912, for all trades above ground level, also basement interior fittings, for the parish church of St. John, Saskatoon. Plans, etc., at the Builders' Exchange, Winnipeg, and at the office of Messrs. Thompson, Daniel & Colthurst, Architects, 410 Drinkle Bldg., Saskatoon.

Saskatoon, Sask.—Tenders will be received up to noon of April 5th, 1912, for the laying of approximattely 23,100 sq. yds. of sandstone block pavement. All information may be had on application to Geo. T. Clark, City Engineer, Saskatoon. (See advt. in Can. Eng.)

Toronto, Ont.—The Dept. of Public Works invite tenders for the erection of an addition to the Registry and Land Titles Office, North Bay, including separate tenders for plumbing, heating and electric wiring. Tenders to be received until March 26th, 1912. Plans, etc., at the Registry Office, North Bay, also at the office of H. F. McNaughton, Secretary to Public Works, Ontario, Dept. of Public Works, Toronto, Ont.

Toronto, Ont.—Tenders for the construction of Section No. 15 (Rosedale Creek Syphon) High Level Interceptor, will be received until March 26th, 1912. Plans, etc., at the office of the City Engineer, Toronto. G. R. Geary (Mayor), Chairman Board of Control. (See advt. in Can. Eng.)

Toronto, Ont.—Tenders for the construction of the Garrison Creek Extension, Section No. 1, will be received up to noon, March 26th, 1912. Specifications at the office of the City Engineer, Toronto. G. R. Geary (Mayor), Chairman Board of Control. (See advt. in Can. Eng.)

Toronto, Ont.—Tenders will be received until March 26th, 1912, for one 30-inch Venturi water meter for the waterworks department. Specifications, etc., at the office of the city engineer, Toronto. G. R. Geary (Mayor), chairman, Board of Control, City Hall, Toronto.

Winnipeg, Man.—Tenders for supply of asphalt required by the city for paving purposes during the year 1912, will be received up to noon, March 20th, 1912. Specifications, etc., at the office of the City Engineer, 223 James Avenue, Winnipeg. M. Peterson, Secretary Board of Control Office, Winnipeg. (See advt. in Can. Eng.)

Winnipeg, Man.—Tenders for the supply of labor and materials required in the erection of approximately 10,560 feet in length of 36-inch wooden stave pipe line, will be received until March 19, 1912. Specifications, etc., may be obtained at the office of the City Engineer, 223 James Ave., Winnipeg. M. Peterson, Secretary Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders for the supply of one or more deep well turbine pumps, driven by electric motor and capable of pumping one million Imperial gallons per 24 hours, will be received until April 1st, 1912. Specifications, etc., may be obtained at the office of the City Engineer, 223 James Ave. M. Peterson, Secretary Board of Control Office, Winnipeg.

CONTRACTS AWARDED.

Athens, Ont.—Public Building.—Contractor: John Dillon, of Seeley's Bay, Ont.

Brantford, Ont.—Mr. T. A. Cowan, of Brantford, has received the contract for the supply of sewer pipes required by the city during 1912. Among other tenderers were the Hamilton and Toronto Sewer Pipe Co. and the Ontario Sewer Pipe Company. T. Harry Jones, City Engineer.

Brooklyn, N.S.—Supply of 20,000 bbls. of cement.—Contractors: Canada Cement Co., Ltd., of Montreal.

Courtenay Bay, St. John, N.B.—Breakwater, Wharves, etc., etc.—Contractors: Norton Griffiths & Co., Ltd., of Montreal.

Hamilton, Ont.—The Hamilton & Toronto Sewer Pipe Company have been awarded the contract for the supply of sewer pipe required by the city for 1912.

Kingston, Ont.—Mr. Michael Sullivan has been awarded the contract to erect the new dormitory of the Royal Military College in this city.

Port Stanley, Ont.—Breakwater and Dredging.—Contractor: M. J. Hogan, of Port Colborne, Ont.

Saskatoon, Sask.—Contracts for the construction of Saskatoon pavements have been awarded as follows: 63,000 yds. at $2.90, to the Bitulithic & Contracting Co.; 20,000 yds. asphalt concrete at $2.80, to the El Oso Paving Co., and 40,000 yds. sheet asphalt at $2.85, to the same firm.

Saskatoon, Sask.—Contracts for the construction of concrete walk and curbing have been let as follows: 14 miles to Western Pavers, Limited, Winnipeg, Man., at 17 cents per sq. ft. on walk and 32 cents per lin. ft. on curb; 7 miles to Robinson & Foster, Spokane, at 16¾ cents on walk and 32 cents for curb.

Toronto, Ont.—The Steel & Radiation Co. have just closed a contract for Crittall Metal Casement windows in the new Canadian Pacific Railway office building, Toronto. This is one of the largest contracts ever let in this type of window. Contract was settled entirely on the merits of the window.

Three Rivers, Que.—Additional filling at new coal docks.—Contractors: J. J. Collins and V. W. Giroux, of Ottawa, Ont.

Vancouver, B.C.—Mr. Bedford Davidson, contractor, has been awarded the contract calling for the erection of a building to be known as the James Borland block. The exterior of the structure is to be faced with buff Clayburn, pressed brick and terra cotta. Parr, McKenzie & Day are the architects.

Vancouver, B.C.—The contract for the construction of the James Borland Block on Hastings Street, was awarded to Mr. Bedford Davidson, contractor. Steel frame work, concrete and brick will make up the construction of the building. Exterior of building is to be faced with buff Clayburn pressed brick and terra cotta. Estimated cost, $85,000.

Vancouver, B.C.—Six-story hotel on Cordova Street, 25 x 122 feet; concrete, brick and mill construction; cost, $60,000; architect, Mr. J. R. MacDonald; contractors, Messrs. Baynes & Horie. Two-story store and office building, Homer and Water Sts.; brick and mill construction; contractors, the Burrard Construction Company; estimated cost, $30,000.

Vancouver, B.C.—The tender of the H. V. Tucker Company for providing crushed rock for all projected road work in North Vancouver has been accepted. It was the lowest of three tenders submitted, as follows: The Producers' Rock & Gravel Company, $120,350; Granite Quarries, Ltd., $110,655; H. V. Tucker Company, $89,285.

Barrett Specification Roofs

"Colonade" Apartments, Kansas City, Mo.
Sellers & Marquis, Roofers.
J. W. McKecknie, Architect.

Best for Apartment Houses.

THE "COLONADE" apartments in Kansas City, Mo., illustrated herewith, have Barrett Specification Roofs.

The owners selected this kind of roofing because they wanted first of all the least expensive roof which would give *proper protection*.

As a Barrett Specification Roof will last 20 years and over without care or attention and as its cost is less than that of any other permanent roof covering, they made no mistake on that point.

The owners wanted *low annual charges*, and Barrett Specification Roofs were satisfactory in that respect as they require no painting or care.

The owners also wanted *proper protection against fire* and as these roofs are considered by fire underwriters as slow burning construction, and as such take the base rate of insurance, everything was satisfactory on that point.

It's always the same story—when ultimate costs and satisfactory service are carefully considered, Barrett Specification Roofs are selected.

Further information about Barrett Specification Roofs will be supplied free on request.

Special Note

We advise incorporating in plans the full wording of The Barrett Specification, in order to avoid any misunderstanding.

If any abbreviated form is desired however the following is suggested:

ROOFING—Shall be a Barrett Specification Roof laid as directed in printed Specification, revised August 15th, 1911, using the materials specified, and subject to the inspection requirement

The Paterson Manufacturing Co., Limited

Montreal Toronto Winnipeg Vancouver St. John, N.B. Halifax, N.S.

Victoria, B.C. — The contract for the erection of the building of the New Method Laundry has been awarded to Messrs. S. and C. Carkreek. It is to be of brick, 114 by 48.

Winnipeg, Man.—Messrs. Seimans Bros. Dynamo Works have been awarded the contract to supply the transformers and switchboards for the city. This firm will install the above previous to June 30th, 1912.

Winnipeg, Man.—Erection of fender, Redwood Bridge; Messrs. Holmes Bros.; cost, $13,156.20.

Winnipeg, Man. — Twenty-four-inch disk rock crusher, Messrs. Mussens Limited; cost, $1,695.

RAILWAYS—STEAM AND ELECTRIC.

Province of Alberta.—The Grand Trunk Pacific Railway officials are desirous of completing the line to Lethbridge as soon as possible. The contract for the grading will be let March 15th, and the work is to be completed this fall.

Calgary, Alta.—The Canadian Pacific Railway are planning to construct fifteen additional sidings in a new yard to be opened adjoining the present one.

Medicine Hat, Alta.—Ald. Howland has made preparations for the introduction of a bill calling for the construction of a street railway in this city.

Port Arthur, Ont.—A report states that the Canadian Northern Railway officials are about to order the extension of their grain elevator at this point to a capacity of 24,000,000 bushels. The present capacity is 7,000,000 bushels. According to the report the work is to commence this spring.

Vancouver, B.C.—The municipal engineering staff under Mr. Fellowes, City Engineer, has been at work on the plans for the crossing projection of that city, in order to have them completed in time for presentation to the Railway Board when that body hold their meeting in Vancouver during the coming spring.

Western Canada.—The C.P.R. work on new stations in the West during the approaching summer will be extensive, and the officials at Calgary are making preparations for new erections at Webb, Namaka, Seven Persons, Winnifred, Danmore, Clive, Nevis, Lougheed, Aldersyde, Jaffray, Burmis, Galloway and Yahk.

LIGHT, HEAT AND POWER.

Berlin, Ont.—The Light Commissioners have decided to discard the gas producer plant and rely entirely on the power of the hydro-electric commission. The plant cost $80,000.

Brantford, Ont.—It is reported that the Lake Erie and Northern Railway will operate their system by means of the hydro-electric current, providing the prices offered are reasonable. This would mean that all towns between Brantford and Port Dover and Brantford and Galt would be along the line of the distributing cables.

Calgary, Alta.—During the month of February, 1912, this city used $8,149.20 of electricity for various power purposes. The receipts of the electrical department of the city for the month of February amounted to $21,417.75. This was made up as follows: Meter light, $20,110.62; flat rate light, $1,289.81; meter power, $9,879.32, and flat rate power, $138.

St. Marys, Ont.—The St. Marys Cement Company have signed a contract whereby that plant will in future be supplied with power from the hydro-electric commissioners. It is estimated the cost of the line and transformers will total $15,000. The original estimate of power rate to be charged was figured on the basis of the town using 500 horse-power. The estimated rate was $29.50 per horse-power. So far the town has been actually using only some 200 horse-power, and paying $38 per horse-power. With the Cement Company sharing the expense the rate will be reduced. It is anticipated that St. Marys will have a rate at least as low as $29.50.

Vancouver, B.C.—The British Columbia Electric Railway have started work on a new sub-station in the district of Collingwood. The cost of this with interior equipment is estimated at $100,000.

GARBAGE, SEWAGE AND WATER.

Montreal, P.Q.—Major Howard has recommended to the Board of Control, the building of about twenty miles of sewers as speedily as possible.

Port Stanley.—The by-law calling for the expenditure of $22,000.00 for waterworks improvement has been carried by the ratepayers.

Ridgetown, Ont.—Mr. F. W. Farncomb, C.E., of London, Ont., acting for the Town of Ridgetown has awarded the contract for the installation of the pumping equipment to the Canadian Fairbanks-Morse Company of Toronto for the sum of $7,500. The equipment will consist of one Fairbanks-Morse 60 H.P. natural gas engine, one Fairbanks-Morse 40 H.P. gasoline engine, two Smart-Turner double acting triplex power pumps and three Goulds deep well pumps. The installation to be complete June 1st, 1912. The contract for the power house and pump well has been awarded to Geo. Poag, of Ridgetown, Ont.

Regina, Sask.—City Commissioner McPherson has been investigating the municipal water supply, and has announced that there is available enough water for a population double that now in the city.

Victoria, B.C.—Ald. Cuthbert has made a motion in the council meeting that the city look for a new and additional source of supply for the water system of the city. Elk Lake has been mentioned as a probable site for a new intake. The Sooke Lake scheme will not be completed for two years at the least and the city's supply must be secured from Elk Lake unless it be augmented through the city's right to purchase water by the gallon from the Esquimalt Water Works Company.

Westmount, Montreal, P.Q.—The recent suit brought by the Montreal Water and Power Company against the municipality resulted in a decision being given in favor of the defendants. The dispute was in regard to the yearly assessment rate of water payment.

BUILDINGS AND INDUSTRIAL WORKS.

Guelph, Ont.—The Crowe Iron Works are about to make an important addition to their plant. Two new buildings and an extra story will be added to the core room, will be erected.

Hamilton, Ont.—The Gartshore Thomson Company are about to erect an addition to their plant. This has become necessary owing to the large contract recently secured from the municipality for cast-iron pipe.

Montreal, P.Q.—Mr. C. A. Reeves, architect, is at present preparing plans for a new school building for the Catholic School Commissioners of Maisonneuve. It will be three storys and basement; 186 x 70.

Montreal, P.Q.—Plans have now been completed for the utilization of the land recently given to McGill University by Sir William Macdonald. It is proposed to erect a gymnasium, swimming bath, a new grand stand to accommodate 8,000 people and new dormitories. The whole scheme is expected to cost about $250,000.

Ottawa, Ont.—The federal government have passed an order in council calling for the erection of the new department building on the Wellington St. site. The preparation of plans for the new building will be considered at once as the congestion existing in the different departments makes necessary the provision of additional accommodation as soon as possible. It is quite probable that either competitive designs will be asked or plans previously prepared on that basis utilized.

Port Moody, B.C.—The Port Moody Sand and Gravel Company has been organized to operate on these materials near this point. One of the largest hydraulic pumps in the province is to be installed by the company to lift the sand and gravel, which test borings have shown exist in immense quantities along the beach just below water level. The company will require 750 horsepower in electrical energy to operate the hydraulic pump and machinery at its bunkers.

Saskatoon, Sask.—Mr. W. R. Sherman of Calgary, has secured a lease of the building of the Star theatre, and announces his intention of spending a cosiderable sum of money to remodel the building.

48 in. CONTINUOUS STAVE LINE.

Manufacturer of
Galvanized Wire Machine Banded
WOOD STAVE PIPE
CONTINUOUS STAVE PIPE
RESERVOIR TANKS
For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

Full particulars and estimates furnished.

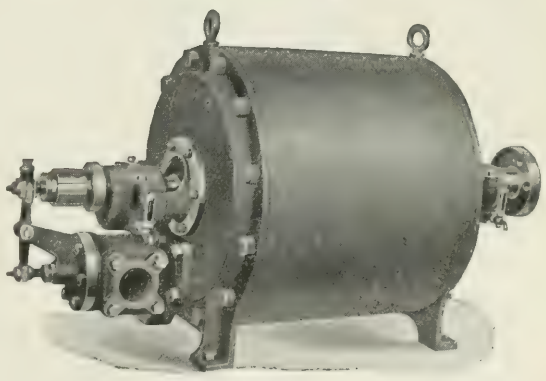
PACIFIC COAST PIPE COMPANY, LTD.
Factory: 1551 Granville Street, VANCOUVER, B.C. P.O. Box 563.

Kerr Turbo-Generators

FOR SMALL LIGHTING PLANTS

The Kerr Turbine is peculiarly suited to generator driving and our sets are made in suitable sizes to fill all requirements up to 500 kw. alternating and 350 kw. direct current. The operation is economical throughout a wide range of initial steam pressures, the steam economy is improved by superheat, and any exhaust conditions are permissible. When operating non-condensing, the steam consumption compares favorably with that of a high speed engine of the same capacity, while in condensing plants the economy at full loads equals that of the best compound engine and at fractional loads is much better.

A Kerr Turbo-Generator for lighting or small power or both is extremely profitable in any plant having power boilers, since the freedom of the turbine exhaust from oil makes reuse of the exhaust inexpensive and safe for boiler feeding or any other purpose where clean low pressure steam is desirable. See Bulletin No. 22.



KERR STEAM TURBINE

Works, 512 WILLIAM ST., MONTREAL

THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO. LIMITED

St. Thomas, Ont.—The Hall and Market Committee of the city have been empowered by the municipal council to secure plans for a market shelter. The cost of this is estimated at $12,000. M. H. Baker, City Engineer.

St. Catharines, Ont.—A proposal to dispose of the present fire hall and erect a new structure has been approved by the council.

Stratford, Ont. — A movement is under way to secure funds for the erection of a $15,000 Salvation Army Citadel in this city.

Taber, Alta.—Messrs. W. W. Douglas, E. B. Tainter and J. T. Willard, are about to organize a company to erect a 200-barrel flour mill in this town. The capital will be all obtained from local sources.

Vancouver, B.C.—Mr. J. R. MacDonald is the architect for a new hotel now under construction on Cordova Street opposite the C.P.R. depot. The building material is to be concrete and brick and the plan calls for mill construction.

Vancouver, B.C.—Messrs. Summervell and Putnam are the architects for a large storage warehouse now under construction for Crane and Company. It is being built with a steel and concrete system of supports. It will have a height of seven stories and will present a face of buff pressed brick laid in an artistic manner. It is to cost $125,000.

Victoria, B.C.—Alexandra Lodge 116, Sons of England, have formed a committee to report on the building of a new hall. It is the intention to erect a handsome hall which will be for the use of the English societies of Victoria in general.

Victoria, B.C.—A site for the erection of a new Roman Catholic Cathedral has been purchased in this city. Bishop Alexander McDonald negotiated the property transaction. The plans for the new building, although worked out in the rough, do not call for the erection to proceed for a short time.

Victoria, B.C.—Messrs. Crompton and Barton are representing the promoters of a new steam laundry, to be known as the New Method. The contract for the erection of the building has been let to Messrs. S. and C. Carkreek.

Winnipeg, Man.—Messrs. Matthews-Laing & Company, of Toronto and Montreal, are planning to erect an eight-story building in this city.

BRIDGES, ROADS AND PAVEMENTS.

Bridgeburg, Ont.—Arrangements are being completed for enlarging the international bridge crossing the Niagara River between Bridgeburg and Black Rock, and a portion of the plant is already on the ground.

Coquitlam, B.C.—The provincial government announce that they will not construct a bridge over the Pitt River during the year 1912. They give as their reason that sufficient money was not appropriated in the estimates for this structure.

Fredericton, N.B.—The contracts for the construction of the following bridges have been awarded by the Provincial Board of Works: Hunter's Ferry Bridge, parish of Canning, Queen's County, awarded to Frank L. Boone, of St. Marys, price $23,000. Cole's Island Bridge, Queens County, awarded to Messrs. Robert and Charles Forbes, of Gibson, the contract price being in the vicinity of $10,000. Messrs. Forbes will also construct the Burpee Bridge in Queens County, the contract price being in the vicinity of $7,000; Mr. Boone has been awarded the contract for the construction of the Chase Bridge, also in Queens County, the contract price being about $3,500.

Province of Quebec.—The government programme of highway construction includes the building of main highways from Montreal to Quebec, Montreal to Rouses Point, to Sherbrooke, and from Quebec to Rimouski and other points, upon condition that the municipalities along the way agreed to pay one-half the interest charge.

Vancouver, B.C.—A conference will be held between the bridges committee and the officials of the Western Canada Power Company, regarding the construction of a bridge for railway purposes.

Welland County, Ont.—This community has prepared plans for road improvement, with the assistance of the government. The county expect to spend $100,000.

York County, Ont.—The York County Good Roads Commission have ordered the paving of the road from Humber Bridge to Mimico Asylum with tar surface concrete, at a cost of $10,000 per mile. The McKnight Construction Co., of Toronto, have secured the contract for the work.

FIRES.

Winnipeg, Man.—Fire damaged the premises of the Radford Wright Company, Ltd., sash and door manufacturers. Loss $50,000.

Winnipeg, Man.—Fire which broke out in the building occupied by Messrs. Gowan-Kent caused damage to the extent of $75,000. One half of the building was occupied by Messrs. Mason & Risch, piano merchants.

CURRENT NEWS.

Clayoquot, B.C.—Plans have been prepared for the construction of a gasoline-propelled cannery tender of about 100 tons register for use at Clayoquot. The power vessel is to be used to carry fish from the fishing grounds at the West Coast port to the cannery. It is expected that construction will be commenced in a few days on this vessel at one of the shipyards in Victoria.

Gloucester, Ont.—The council of this town have passed an order calling for the purchase of a quantity of dynamite to be used in breaking the ice in the Ottawa River.

Guelph, Ont.—The City Hotel was damaged by fire to the extent of $25,000 or more.

Prince Rupert, B.C.—A report states that Mr. D. C. Whiteford has discovered a valuable salt well on his claim at 46 mile, Grand Trunk Pacific Railway. A gallon of the water from the well when evaporated gives one-half pound of salt.

Medicine Hat, Sask.—This municipality will spend $200,000 on local improvements during the present year.

Province of New Brunswick.—A company is being formed to operate on the New Brunswick shales. They will apply for a charter from the legislative assembly. Messrs. Inches and Hazen, St. John, N.B., are the solicitors for the company.

Ottawa, Ont.—The proposed plan to appoint a city architect has taken definite shape. Ald. Nelson and Black are interested in the matter.

Owen Sound, Ont.—The ratepayers voted in favor of the three industrial by-laws as follows: The drydock and shipbuilding by-law, 1,794 to 85; the Aetna Rubber by-law, 1,863 to 28, and the cement by-law, 1,820 to 51.

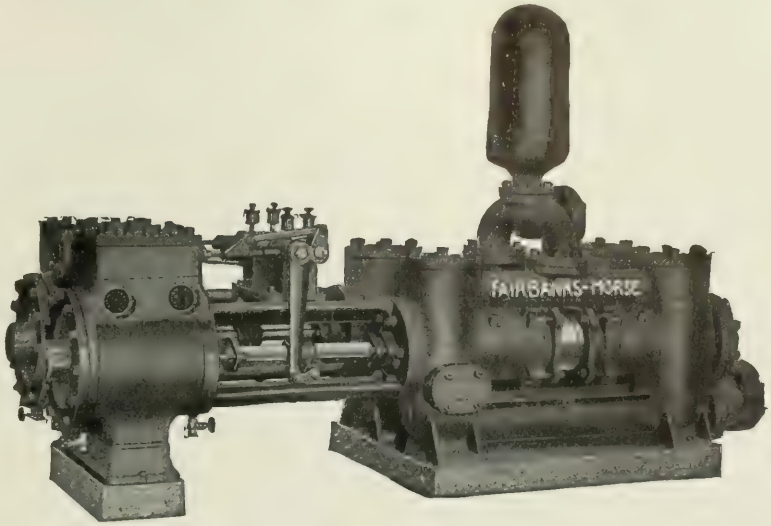
Porcupine, Ont.—The Bank of Toronto have just completed a new banking office in this town. This is the first brick building in Porcupine.

Port Alberni, B.C.—The proposed erection of the new public school at Port Alberni will not be proceeded with immediately, all of the tenders received in response to the government's invitation for bids being found disproportionately high. Fresh tenders will probably be asked for.

St. Catharines, Ont.—The ratepayers will vote on a by-law calling for the purchase of the plant of the St. Catharines Gas Company for $38,000.

Vancouver, B.C.—The Great Northern Railway Company improvements have been undertaken and are now well started. Considerable work of a preliminary nature has been done on the dock site, next to the British Columbia Sugar Refinery Company, and contracts have been let for some of the grading and filling for the False Creek project.

Victoria, B.C.—Mr. Louis Coste has presented his report on the cost of improving the harbor of this city. A breakwater to cost $1,250,000 and a pier to cost $400,000. As to the outer harbor, Mr. Coste does not think it advisable to recommend for the present the construction of such a breakwater as would be required to afford protection from the south-west. Such a breakwater would cost $2,500,000. as it would have to be 3,000 feet in length and to extend into a depth of water of 250 feet. Moreover, while protection in that quarter is desirable, the large steamers are not greatly



PUMPS

The superior excellence and splendid results shown by

"FAIRBANKS-MORSE"

pumping machinery are largely due to the fact that for many years we have manufactured Hydraulic Machinery of all descriptions. We are therefore able to build pumps which are properly designed and adapted to every-day use. This is of the greatest importance in a first-class pump, for the usefulness of an engine may be lost if the pumping machine is badly designed.

You will get all these important features when you purchase a "FAIRBANKS-MORSE" pump.

Let us solve your pump problems.

THE CANADIAN FAIRBANKS-MORSE CO. Limited

Fairbanks Standard Scales — Fairbanks-Morse Gas Engines.
Safes and Vaults.

Montreal Toronto Winnipeg Vancouver Calgary St. John, N.B. Saskatoon Ottawa

inconvenienced by the south-west seas. Protection from the more frequent south-east gales is much more necessary, and much easier.

Victoria, B.C.—The officials of the Pacific Coast Steamship Company have had plans prepared for the construction of two new ships. They have called for tenders to be in by March 20th. This line operates from Puget Sound to San Francisco.

A company has been formed in Paris, France, to operate and develop Canadian resources, chiefly minerals. It is proposed to increase the French population in this country by these means.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ended February 12th, 1912. Fuller information may be obtained by communicating with the Department of Trade and Commerce, Ottawa.

A London firm desire to get into touch with Canadian importers of chemicals and oils.

A firm in Wales who specialize in zinc dross, zinc skimmings and sal skimmings, etc., wish to get into correspondence with a Canadian firm willing to enter into a mutual arrangement to work the business.

A London firm make inquiry for the names of Canadian importers open to appoint a buying agent in Great Britain.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:

A French manufacturing company seek supplies of Canadian balsam gum and invite prices and samples from producers.

A London firm manufacturing a specialty in desiccated yeast are looking for some suitable resident Canadian firm to undertake its introduction and sale.

ENQUIRY FOR "TIE PLATES."

Mr. F. C. Gamble, Chief Engineer, Dept. Railways, British Columbia, desires to ascertain the names of firms manufacturing railway tie plates of all descriptions and the prices of the same.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16053—March 1—Directing that G.T.R. install gates to be operated from tower at point where its railways crosses Hope and Woodstock Sts., Tavistock, Ont., 20 per cent. from "Railway Grade Crossing Fund," remainder by G.T.R., 15 per cent. of cost of maintenance and operation of gates to be paid by village of Tavistock.

16054—March 1—Refusing application of J. M. Morin, K.C., for an Order to compel C.N.Q. Ry. to macadamize and keep in good repair highways and abutments of bridge between Bout de l'Ile and Charlemagne, Que.

16055—February 29—Authorizing C.P.R. to construct spur to premises of Canadian Equipment & Supply Co., Ltd., Calgary, Alberta.

16056—March 1—Authorizing C.P.R. to grant special rate to mining students of McGill University from Montreal to Rossland, Phoenix, and Greenwood, B.C., at $40 and return, and side trip, if desired, from Slocan Jct., to some point on Sandon Branch at rate of ¾ cent per mile each way, and providing that any other parties desiring to travel to B.C. or other mining district, be granted equally favorable terms, etc.

16057—March 1—Directing that K. & P. Rly. jointly with C.P.R. file within 40 days from date of this Order tariff establishing a rate of 10¾ cents per 100 on ex-lake grain, in carloads, from Kingston to Montreal, including stop-over at Almonte for milling purposes. Application, Wylie Milling Co., Almonte, Ont.

16058—February 13—Authorizing G.T.P. Ry. to cross highway in Parish of St. Francois Xavier, and to divert highway, mileage 119 to 119.3, Dist. of Winnipeg, Manitoba.

16059—March 4—Directing that rate of 80 cts. per 100 lbs. charged by C.P.R. on lumber from Port Arthur and Fort William to Vancouver be disallowed; and that C.P.R. within 30 days of Order substitute in lieu a rate of 55 cents per 100 pounds on lumber (including flooring) in carloads of a minimum of 40,000 lbs.

16060—January 12—Authorizing C.N.R. Alberta Ry. to cross with its main line the G.T.P. main line in S.E. quarter of Sec. 31, Twp. 53, R.10, West 5th.M. Interlocking plant to be installed.

16061—March 2—Directing that express classification for Canada No. 2 be amended making certain changes in newspaper rates from Winnipeg to Calgary; complaint of the Manitoba Free Press Co. of Winnipeg, Man.

16062—March 4—Approving location and revised location of C.P.R. Wilkie Northwesterly Branch (formerly known as Manitou Lake Branch) as follows: location from mileage 0 to 12.86 and from mileage 26.85 to 32.15; revised location from mileage 12.86 to 26.85.

16063—March 1—Authorizing C.P.R. to construct an extension of 150 feet to siding on Lot 15, Con. 1, Twp. of Trafalgar, County of Halton, Ontario.

16064—March 1—Authorizing Council of Mun. of Bridgeburg, Ont., to carry street over G.T.R. and M.C.R. in village by means of an overhead bridge.

16065—March 6—Authorizing G.T.R. to reconstruct swing bridge over Lachine Canal, in City of Montreal, Que.

16066—March 6—Exempting Vancouver, Victoria and Eastern Rly. from use of "zinc covering over caps and intersections," as required by Order No. 11446 of Aug. 2nd, 1910, where oil burning engines alone are used.

16067—March 5—Authorizing White Pass & Yulon Route to publish tariffs (special) within less than statutory notice, for excursion business, etc.

16068—March 5—Authorizing James Bay & Eastern (C.N.R.) (Roberval Extension) to construct bridge over Iroquois River, Twp. of Ashuapmouchouan, County Lake St. John, Que.

16069—March 5—Approving plans for lowering of three foot pipe under M.C.R. tracks in Twp. of Wainfleet, Ct. Welland, Ont.

16070—March 5—Authorizing G.T.P. and C.N.R. Rlys. to operate trains over interlocking plant authorized by Order No. 14304 of July 20, 1911, without coming to a stop.

16071-72—March 5—16073—March 6—16074—March 5—Authorizing C.P.R. to construct spur for City of Winnipeg, Manitoba, for Messrs. G. P. Sherwood and Company, Montreal, Que.; for Stoneclough Quarry Co., near Coldwater (G.B. & S. Ry.) Twp. of Medonte, Ct. Simcoe, Ont., and for siding with spurs therefrom for St. Mary's Portland Cement Company and rescinding Orders 15667 and 15969 dated respectively Dec 15th, 1911, and Feb. 13th, 1912.

16075—March 5—Approving portion of C.P.R. Swift Current Southeasterly branch from mileage 40 to 45, and to construct across three highways.

16076—March 5—Authorizing C.P.R. to construct across highways from mileage 0 to mileage 35.25 as shown on location plan No. 1105.

16077—March 4—Authorizing C.P.R. (G.B. & S. Ry.) to divert public road between Cons. 7 and 8, in Twp. of Eldon, County of Victoria and to construct tracks across said diversion at mileage 56.4 by means of overhead bridge. Compensation to be paid John McArthur for injury sustained to property and rescinding Order No. 15987.

16078—March 7—Authorizing C.N.R. to cross and divert public road on its Maryfield extension.

16079-80—March 5—Authorizing C.P.R. to construct spur for Sidney Brick and Tile Co., at Sidney, Man., and for Guelph Stove Co., Ltd., Guelph, Ontario.

16081—March 5—Approving location of C.N.O. Ry. (Sudbury-Port Arthur Line) from mileage 2 at Current River in City of Port Arthur to a point in Lot No. 5E in Twp. of McGregor, at mileage 6.49.

16082—March 7—Approving revised location of G.T.P.B.L. Co., Regina Boundary Branch, mileage 84.22 to 91.13, Sask.

16083—March 5—Authorizing Mun. of Twp. of South Gower to construct highway across C.P.R. Twp. of Oxford, Ct. Carleton.

16084—March 7—Approving revised location of G.T.B. B.L. Co., Regina Boundary Branch, mileage 17.02 to 84.22.

16085—March 7—Approving by-law of Central Ontario Railway authorizing George H. Shaw to prepare and issue tariffs of tolls.

16086—March 6—Approving location of C.N.O. Ry. (Montreeal-Port Arthur Line) through Twps. of Crerar, Dana, Janes and Davis, Dist. of Nipissing, mileage 386 to 406 from Montreal.

16087—March 6—Approving revised location of C.N.O. Ry. (Montreal-Port Arthur Line) through unsurveyed territory Sudbury District, mileage 191.6 to 193.7.

16088—March 7—Authorizing C.P.R. to construct industrial spur for Chinook Coal Co., Ltd., near Kipp, Alberta.

16089—March 8—Directing C.N.R. to cease from blocking lanes and streets in City of Brandon, Man., under penalty of $50 and that the company plank railway track before May 1st, 1912. Complaint, J. I. Parkin.

16090—March 8—Directing that rule be added to conditions of carriage and directions to agents in express classification for Canada No. 2, namely:—"A shipment tendered at a common point which cannot be carried to its destination except through a connecting company, which connecting company has also an office at the common point, must be refused, and the shipper be referred to the company which can give the through service; unless, having been notified of the charges by the joint route, he requests acceptance and specifies the route in writing, in which case the shipment may be forwarded at the sum of the local rates to and beyond the transfer point specified by the shipper." "The transfer point must be indorsed on the agent's receipt, and the shipper's written request attached to the way-bill."

16091—March 7—Authorizing South Ontario Pacific Ry. to operate connection of its Guelph Jct. to Hamilton Line with tracks of T.H. & B. Ry. for construction purposes only until 31st May, 1912.

16092—March 7—Authorizing Vancouver, Victoria & Eastern Ry. to open for the carriage of traffic its railway from Princeton to Coalmont, a distance of 13 miles.

16093—March 6—Authorizing C.P.R. to construct spur for City of Winnipeg, Manitoba.

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An Engineering Weekly

PITOMETER SURVEY OF WATER MAINS.

The means of rapidly determining water losses by mechanical means will be greatly appreciated by waterworks engineers and others having occasion to give serious thought to the subject.

There has of late been brought to a very satisfactory state of perfection an instrument known as the pitotmeter, which is designed to indicate water waste and main losses. A great advance over other methods of water waste investigation has been brought about in this instrument, inasmuch as the main does not have to be cut. This instrument is primarily a rate meter, depending on the velocity of the water in the main. Two brass tubes bent at their lower ends with carefully formed orifices of ⅛-inch internal diameter are held in a suitable cap which screws upon a standard 1-inch corporation cock through which the tube may be readily introduced into any main and as easily withdrawn. Heavy cloth-insertion rubber tubing connects the orifice tubes with a long glass manometer oe U tube, and blow-off cocks are provided to remove the air from the instrument.

The Pitometer Company, 220 Broadway, New York, recently made a pitotmeter survey of certain sections of Toronto, and their report was made to the city a few weeks ago. Mr. E. A. Howland was in charge of the survey for the Pitometer Company.

A district about six blocks square (larger on matters according to the consumption) was taken and all the boundany valves closed except one. A photo recording pitometer was placed on this main and the flow gauged for forty-eight hours. If the district was residential and showed a high night rate between the hours of twelve and five, it was subdivided between those hours to find the cause.

The U-tube was filled with a mixture of carbon-tetrachloride and benzine having a specific gravity of 1.25 and when in use the water from the pipes filled the remaining space in the U-tube.

This was done by closing the inside valves supplying the various streets, and noting the drop in flow as the valves were closed.

If a street was found to have an abnormal flow, the curb cocks were closed, and if a house had any waste the amount would at once be shown by the fall of liquid in the manometer. The curb cocks were sounded with an aquaphone, before being closed, and if leakage was detected, again after. If the flow stopped on closing the curb cock, the leakage was evidently on the house side of the curb cocks. After all the curb cocks had been shut off the valve on the main supplying this street would be closed, if a drop in flow was then noted, it would be caused by leakage on the main or services up to the curb cocks. This could then be located by means of the aqua-phone and connections.

The orifices are set to receive the maximum velocity within the main, which is usually near the centre, and is indicated by the deflection in the manometer.

This deflection, by virtue of the differential action of the water and the slightly heavier and insoluble liquid, is just four times that due to the actual difference of water head on the orifices produced by the flowing stream.

The current impinges directly on one orifice, but the other is turned directly down stream and gives something less than the static head within the main, thus increasing the difference of pressure produced. This difference is then multiplied in the U-tube, the result being that a low velocity within the pipe produces a readable deflection.

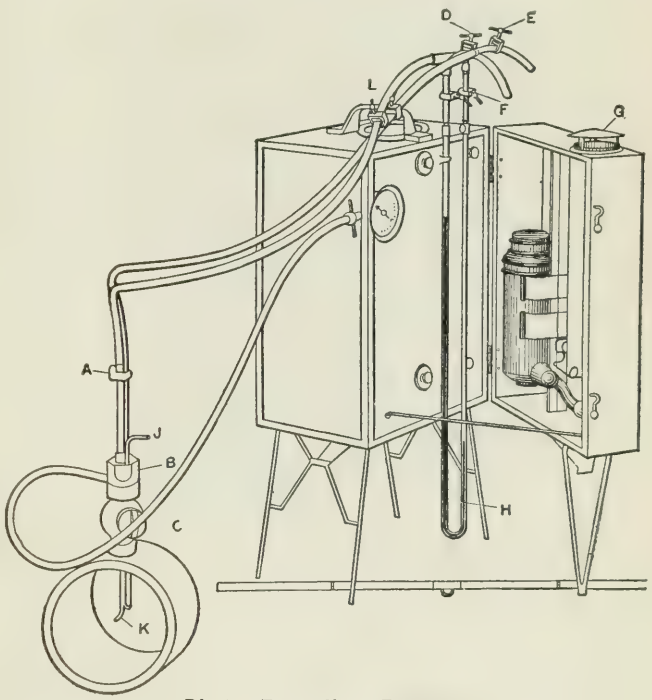


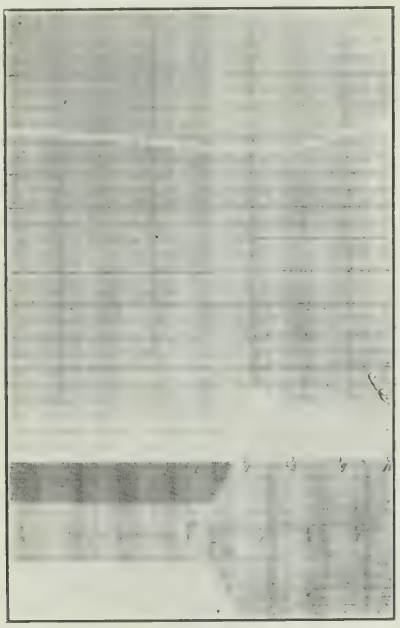
Photo Recording Pitometer.

The photo recorder consists of a portable box in which a drum carrying sensitized paper revolves before a fine vertical slit just in front of which is locked one leg of the U-tube, in such a position that the rays of light from a lamp will be partly interrupted on their way through the colored liquid in the lower half of the U-tube. As the liquid rises and falls with the velocity in the pipes it will record a line or band of shade on the velox paper whose ordinates vary according to the well known formulae $v = c\sqrt{2gh}$ in which h is ¼ of the U-tube deflection in feet or half of the recorded ordinates on the paper, C=0.84 the calibration coefficient of orifices. A prism attachment records the full deflection at low velocities.

Autographic horizontal lines are formed by notches in the drum split, spaced so as to **correct** for the angularity of the light and enable the true deflection to be readily taken **from the diagram at any point.**

To determine the quantity of water being discharged, a traverse is first made of the pipe at the gauging point, and from this traverse the pipe coefficient (mean velocity divided by center velocity) is obtained. The orifices are then left at the center and the mean velocity at any rate of flow may always be found by multiplying the center velocity by this coefficient.

A preliminary test of the first district was made in August, 1911. There was then a steady flow between 1.30 a.m. and 5 a.m. at the rate of 395,000 gallons per 24 hours. The district was subdivided and it was found that this high night rate was quite evenly distributed over all the streets. The services were sounded with an aqua-phone and a large number of houses were found to have a continuous flow of water during the night. The mains were also carefully sounded and no evidence of leakage could be found. Inspection of the fixtures in the houses in this district showed a large number of leaks, but in several houses with a continuous night flow, the fixtures were found to be in good condition, thus showing wilful waste.



A Photo Record With Prism Attachment Recording Both Legs of U-Tube.

A district almost entirely residential was gauged, and the minimum night flow found to be 395,000 gallons per twenty-four hours, or about 77.75 per cent. of the mean flow.

A few services were found to be leaking between the curb cock and the main, and these were repaired. After these repairs had been made and the houses inspected, the night flow was again taken and showed a reduction of only 50,000 gallons per twenty-four hours.

As this district was still in a very unsatisfactory condition, the engineers took the streets with the heaviest night flow and shut off all the services; it was then found that the flow to these streets stopped. This showed that the waste was in the houses and that there was no leakage in the mains.

A leak of 170,000 gallons per twenty-four hours was found; this was caused by a break in a 1-inch service pipe, which singularly enough occurred just inside a sewer through which it passed.

The twenty-two districts gauged with the recording pitometer showed a total mean flow of 10,618,000 gallons per twenty-four hours, and a minimum night flow at the rate of 7,185,000 gallons per twenty-four hours, or about 67½ per cent. of the mean flow.

In the districts subdivided, it was found that the high night flow is almost entirely caused by waste inside the houses. This is due to leaking fixtures, careless and wilful waste, and can only be controlled by the installation of meters.

The mains in these districts are remarkably free from leakage, as shown by our tests, for after closing all the curb cocks the flow practically stopped, thus proving the mains to be tight.

CONCRETE ROADWAYS.

Concrete roads have been the principal type of road built by Wayne County, Michigan, and concrete roads are the accepted standard of construction. The road commissioners state that their aim is to provide the county with durable, permanent roads. They believe that the concrete road that they devised and built has accomplished their purpose, and that that type of road is the coming roadway. It is a road that is low in ultimate cost, pleasing to the eye, smooth, dustless, and affords excellent traction for all types of vehicles. While their early efforts at concrete road building were somewhat experimental they have devised several means in their methods of construction which will add materially to the life of concrete roads. Among the more important improvements have been.

(1) The increase of the amount of cement used in the mix, changing from 1-2-4 mix to 1-1½-3 mix;

(2) More stringent specifications as to quality of stone and sand;

(3) An increase in the depth of the work to not less than 7 inches;

(4) A protecting plate at the expansion joint.

The Eureka road in Wayne County is a typical example of the type of roads built. Eureka road is one of the principal roads leading into Wyandotte. It is built of concrete of a 1-2-4 mix with 12 feet of metal, 23 feet over all at its narrowest point. It was built last fall, and additional mileage will be constructed at an early date.

The following is a statement of the expenditures on Eureka road, a stretch one mile in length, up to and including September 30, 1911:—

Roadway Proper.	Cost.	
Teams	$ 980.00	
Other labor	3,364.15	
Pebbles, tons 2,014	1,657.78	
Sand, tons 700	684.94	
Cement barrels 1,218	1,723.97	
Coal, tons 60.75	189.45	
Expansion joints	77.60	
Lumber and engineers stakes	14.31	
Water supply	110.14	
Blue prints, advertising photos	11.47	
Lubrication, waste, etc.	48.51	
Liability insurance	49.41	
Hardware and repairs	27.50	
Express, messenger and auto	53.03	
Miscellaneous	48.81	
		$9,041.07
Drainage.		
Open ditch	$ 265.01	
Tile drains	48.84	
		313.85
Total cost of roadway proper with drainage		$9,354.92

SOME NOTES ON COLUMN DESIGN.

By F. Tissington.

During the course of some ten or twelve years structural designing the writer has found it necessary on more than one occasion to compare the different column formulæ that are being constantly used, in order to get a true idea of their respective values.

Nearly every handbook issued by the different steel companies, as well as most of the current text books on designing, specify a particular formula having its own peculiar merits, and these, together with government specifications, produce a most formidable array of figures, which, to the average draughtsman and designing engineer, makes it almost impossible for him to select a particular formula as most suitable to his case.

Some years ago the writer compiled a series of tables and curves relating to column and strut formulæ in use at that time in England, and he found there was a large difference of opinion between the various authorities as to what constituted a safe load for a particular case, and in consequence of this he came to the conclusion that the only remedy, in order to design in a safe as well as in a commercial sense, was to pick out one particular set of figures and stick to them.

Professor Fidler's formula was the one finally adopted, and this was chosen in preference to any of the others, in consequence of the fact that it made an allowance for initial set or eccentricity of loading, which is almost certain to occur in any strut or column from one of several causes. For instance, it is almost impracticable to produce commercially either a simple or compound strut perfectly straight, and with the centre of gravity of every cross-section exactly coincident with a straight line drawn from two points at either end of the member which do coincide with the centre of gravity at those points.

Again, no structural material yet produced has been perfectly homogenous throughout, and this state of affairs produces the same effect as that outlined above, even supposing the member could be made perfectly symmetrical with the centre of gravity line.

A slight modification was made to Fidler's formula by adopting a sliding factor of safety. This consisted of the following:

Factor of safety for dead loads $2.5 + .01\,h$

Factor of safety for live loads $3.0 + .015\,h$

where h = value $\frac{Z}{r}$

Z being unapported length in inches.

r = least radius of gyration.

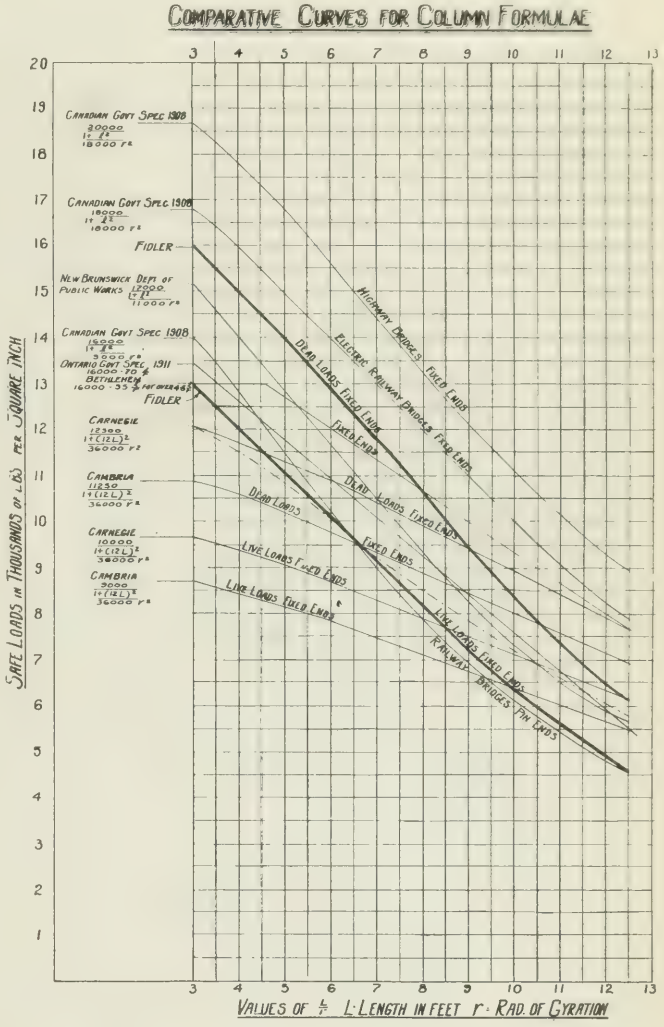
Since the writer has been over on this side he has found the same trouble, and nearly every design has to be figured on by a new set of column formulæ. The consequence is that there is very little practical value to be obtained from the compiling of tables of made-up struts and columns unless a new one is made for each new formula.

The diagram No. 1 will give a very good idea of what is meant, and the curves represent a fair sample of the different sets of figures the average designer meets in the course of a few months.

For the sake of comparison Fidler's formula, as used by the writer, has been plotted, and the two heavy lines represent the dead and live load curves for fixed ends as specified.

It will be noticed that the Canadian Government specification, 1908, for highway bridges for struts with fixed ends gives the highest value, but it should be remembered that there is an impact increment to allow for, consisting of $\frac{L^2}{L+D}$ where L = live load stress and D = dead load stress.

This, taken in a general way, reduces the allowable stress per square inch by about 35 per cent., in order to compare same with the other figures, and this new value is shown by the dotted line.



The other two curves belonging to the same specification—one for electric railway bridges and the other for railway bridges—would be reduced in a similar manner, but have not been shown.

The Cambria and Carnegie hand books give curves which represent very low values of permissible stress for low values of $\frac{L}{r}$ and relatively high values as the ratio $\frac{L}{r}$ increases.

This appears to the writer to be bad practice, as these formulæ do not take advantage of the stiffness of short columns and neglect to allow for the extra amount of flexure in long columns.

It was for this very reason the sliding factor of safety was adopted by the writer, although there is another point of view which ought to have some bearing on this as well.

For instance, if you take, say, a column of four square inches sectional area, and assume two cases,

(1) Where the value of $\frac{L}{r}$ is 3.

(2) Where the value of $\frac{L}{r}$ is 12

By using, say, the Fidler formula for live loads we obtain the following:

	Permissible stress, square inch.	Area.	Total load allowable.
(1).....	13000	4	52000
(2).....	5500	4	22000

Now, in computing loads, a great deal of guesswork has to be done for general designing, more particularly so far as wind and snow loads are concerned, and although our information on these points is getting more complete we are still likely to make mistakes, as is evidenced by the failures that take place from time to time.

Therefore, assuming that in this particular case we arrive at the correct loading by about 10,000 lbs, this would amount to, say, 20 per cent. increase in the first case, which is not very serious, and 50 per cent. increase in the second.

It will be seen, therefore, that if we calculated on the Carnegie formula for live loads factor of safety five, we should require 3.4 square inches @ 6,400 lbs. to carry the 22,000 lbs. load in the second case but with the increase of the load to 32,000 lbs. our stress on the 3.4 square sectional area would jump to 9,400 lbs. per sq. inch, whereas, with Fidler's formula the actual stress would be 8,000 lbs. square inch.

It is evident that a small increment of loading on a column with a large value of $\frac{L}{r}$ is likely to prove dangerous, but with small values of $\frac{L}{r}$ the percentage increase being considerably lower, this is not so serious, and, therefore, the most rational factor of safety is the sliding one of a similar type to that given above.

The curves given on the diagram No. 1 may all be quite safe if applied in the particular way intended, but are they all sound commercially? That is, can they be used in a competitive sense, and further, is the indiscriminate use of these formulæ to be recommended?

The writer is of the opinion that it would be an immense gain to the manufacturers in this country if a standard series of curves could be arrived at, and there does not seem to be any reason why one set of figures should not meet the case.

Starting, say, with columns for dead loads, fixed ends, it would be a simple matter to fix a reduction of so much per cent. for live loads and a further reduction per cent. for impulsive loads. The same could be done for pin ends, and the whole thing would then lend itself very well to the compiling of standard tables, which would count for efficiency and a great saving in labor in the designing office.

A LONG TUNNEL.

The Nepton tunnel, now being driven in the Pachuca, Mexico, district, will be over six miles long when completed. It lies at a depth of about 1,400 feet below the city of Pueblo. It was started 18 years ago, but only about two miles has been completed. It will drain the Pachuca mining district and afford an outlet for the different mines.

TELEPHONE COMPANIES OF CANADA.

Canadian Telephone statistics compiled to the end of June, 1911, have been completed by the Department of Railways and Canals, and issued in the form of a report. This is the first attempt of the Department to prepare statistics relative to the telephone in Canada, and it is to be regretted that more managers did not comply with the request of the Department in furnishing material for a more comprehensive and larger report. In all 537 companies forwarded a complete or semi-complete statement, and of these the province of Ontario was shown to have the bulk of Canadian telephone business by a great lead. The report, when divided into provinces, resulted as follows:

Ontario	319
Quebec	32
New Brunswick	16
Nova Scotia	14
Alberta	4
Saskatchewan	143
Manitoba	3
British Columbia	5
Prince Edward Island	1
	537

In the provinces of Manitoba, Alberta and Saskatchewan the Provincial Government has, in a certain measure, taken over the management of the telephone companies in their respective provinces. This is particularly the case in the two former provinces; as all the separate organizations which previously existed have been merged under the control of the government. In Saskatchewan the process of government absorption has taken definite form, but at the close of the month of June last there were still 142 companies holding their independence.

Of these 537 companies a great number are classed as rural, and these have, as a rule, an equipment of the lowest possible monetary value, and represent the so-called "party lines."

The combined capital of these 537 companies amounted to $40,043,982.29; of this total the province of Quebec had a combined capital of almost $19,000,000. This is the largest amount of money invested in telephones of any province of Canada, and may be accounted for by the fact of the heavy capitalization of the Bell Telephone Company in Montreal.

The gross earnings reported totaled $10,068,220, and of this sum $6,979,045 was operating expense; being a percentage of operating expense to income of 69.32 per cent.

At the close of June, 1911, the combined length of telephone wire of the various Canadian companies was represented by 687,728½ miles of wire, and to this length 302,759 instruments were connected. The mileage of wire was divided into 576,712¾ miles for urban use, and 111,015¾ miles for rural purposes.

The energy required to operate these instruments is derived from two sources, viz., central energy and magneto. Of these 174,994 were operated by the latter means and 127,765 by the former.

A FLOODED SUBWAY.

The Wellington Street subway of the Grand Trunk Railway in Montreal was so badly flooded by the thaw recently that street cars were held up, and passengers were put to much inconvenience. As soon as the drains were opened up the regular service was resumed.

REPORT ON VICTORIA HARBOR.

The report of Mr. Louis Coste, M.I.C.E., the engineer sent by the Public Works Department at Ottawa last December to investigate the requirements of Victoria, B.C., with a view to equipping this port for the great shipping development of coming years, have been made public. They outline the preliminary details for the construction of adequate harbor works for Victoria, the first part of a great scheme of development. Mr. Coste's plan is for progressive construction, making provision for enlargement as the trade develops, and no time is to be lost in beginning the work. Construction is expected to begin on the breakwater from Ogden Point, the first work, in the near future.

A breakwater of concrete blocks surmounted by a concrete wall, 2,500 feet in length, is to extend westerly from Ogden Point, with a concrete pier 1,100 feet long on the inner side, the breakwater to cost $1,250,000. Four other large concrete piers, with spacious warehouses and modern cargo-handling facilities, and a railway ferry slip where the car-ferries can load and unload their trains, will be built. The piers will be of 500, 700, 720, 800 and 1,100 feet in length, and these will be built immediately following a survey and borings, the construction of the first of the piers being hurried to increase the present accommodation for large ocean going steamers in view of the rapid increase of the shipping of the port. It is estimated that this pier will cost $400,000. The proposed piers will offer 6,400 feet of berthing for steamships and with the outer wharf piers accommodation will be provided for over a score of ocean-going steamers.

To connect the harbor works with the railroad terminals on the Songhees reserve a bascule bridge will be provided from the reserve to Laurel Point with trackage on Montreal Street to the various piers. The railroads will thus be enabled to move their trains to and from the seven great warehouses and the grain elevator to be provided.

For the growing coastwise trade the inner harbor is to be greatly developed, a comprehensive scheme for dredging, deepening and the clearance of obstructions being outlined. Much reclamation work is to be done, and the haror lines are clearly defined.

Mr. Coste recommends that the placing of the port under a harbor commission be considered. His reports follow:

The harbor of Victoria is situated at the southeast end of Vancouver Island, practically at the junction of the Strait of Georgia and the Strait of Juan de Fuca. This harbor is divided into two parts, known locally as the inner harbor and the outer harbor.

The inner harbor extends from Shoal Point on the east side and McLaughlin Point on the west side, to the east end of James Bay in an easterly direction, a distance of one and a half miles, and to Selkirk waters in a northerly direction, a distance of nearly two miles. The available depth of water, at lowest tide, in the channel, and close in to the principal wharves, is 20 feet, obtained almost altogether by dredging and blasting operations. This depth of twenty feet is, in my opinion, the maximum depth to which that part of Victoria harbor should be dredged, as the restricted area of possible navigable water limits the sizes of the steamers which can utilize it to a maximum length of 350 feet, and a draft of 17 feet.

This inner harbor is a very valuable asset to the city city of Victoria, to the province, and to Canada generally. Its coasting trade is very large, and is increasing annually at a rapid rate, but it is not possible to accommodate large ocean liners within its limits, and this has rendered necessary the creation of the outer harbor, with which this report deals exclusively in so far as required works are concerned.

The outer harbor of Victoria is immediately south of the entrance to the inner harbor. It may be said to extend from Shoal Point to Holland Point, on the east side, a distance of 6,000 feet, and from McLaughlin Point to Macaulay Point, on the west side, a distance of 3,000 feet, comprising an area of nearly 300 acres of water, varying in depth from 30 to 80 feet. In that harbor the spring tides rise 7 to 10 feet, and the neaps 5 to 8 feet, the low tides being very irregular. The datum for excavation by the Public Works Department is the zero of the gauge of the old customs wharf.

Mr. Coste suggests that a breakwater 2,500 feet in length should be built of a rip-rap foundation surmounted by a concrete wall protected on the seaward side by concrete blocks. This will protect all the wharves and the entrance to the inner harbor. The estimated cost of this breakwater is as follows:

Rip-rap stone, 365,000 cubic yards at $1.40.....	$ 511,000
Concrete wall, 36,000 cubic yards at $8.00.....	288,000
Concrete blocks, 4,000 cubic yards at $9.00.....	365,000
	$1,164,000
Superintendence and contingencies	86,000
	$1,250,000

The project of wharf development comprises a railway ferry slip, four piers respectively 500, 700, 720 and 800 feet in length, and in addition a wharf 1,100 feet in length along the inner face of the breakwater.

Among other things Mr. Coste recommends:

1. That the breakwater be built; cost, $1,250,000;

2. That a survey of the outer harbor be made at once to ascertain the cost of building wharves as shown on plan;

3. That, as soon as the survey is completed, pier No. 1 be built. Approximate cost, $400,000;

4. That negotiations be entered into with the Provincial Government, the Canadian Pacific Railway and the Canadian Northern Railway, with a view to affording rail connections to the outer harbor, by the construction of a bridge between the Songhees Point and Laurel Point or otherwise;

5. That the question of placing the whole of the harbor of Victoria in commission, be considered.

He also suggests for the inner harbor:

1. That a thorough survey of the harbor of Victoria be undertaken at once, boring being essential;

2. That the programme of works to be done by the plant owned by the government, recommended in this report, be approved, and instructions given accordingly for carrying it out;

3. That the shoal east of Songhees Point be removed by contract work as soon as the survey of the harbor is completed;

4. That that part of the harbor known as West Bay be thoroughly examined, to ascertain whether or not it is feasible to build in that bay a modern railway terminus, consisting of ferry slips and wharves.

As an emergency putty a new use was recently found for old newspapers. A party being in need of a crack filler and not being in a convenient position to obtain the real article made a boiling mixture of one pound flour and three quarts water and then soaked the paper, when the liquid had assumed a pasty condition.

The filler dried hard and did not shrink to any extent.

STEAM AND HYDRAULIC MACHINERY.

For many years Messrs. W. H. Allen, Son & Co., Ltd., of Queen's Engineering Works, Bedford, England, (and who are now represented in Canada by Messrs. Chapman & Walker, of Toronto) have occupied a prominent position as makers of high-speed vertical steam engines, steam condensers and their accessories, centrifugal and turbine pump and water power turbines. We therefore give below an illustrated account of some of the types of machinery just referred to which is certain to prove of interest to our readers, especially as Messrs. Allen's engines and pumps are to be found on all the leading ships in our navy, and on practically all the largest liners afloat.

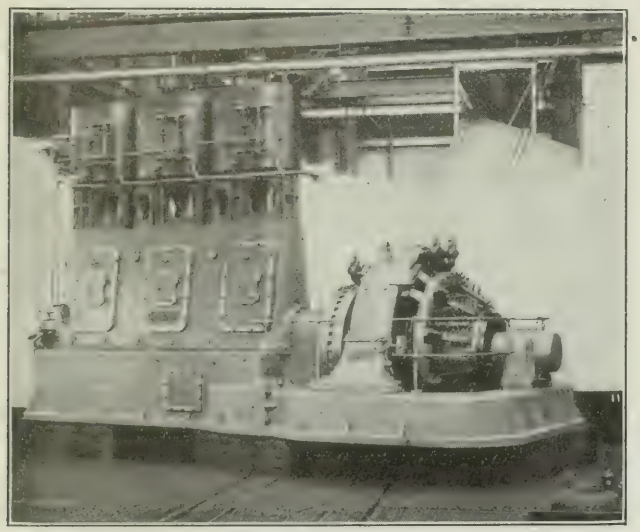


Fig. 1.

Engines.—These are built in both the open and the enclosed high-speed types. The enclosed high-speed engines are of the vertical forced lubrication type, the oil being supplied under pressure by a small valveless plunger pump driven direct from one of the main eccentrics. The cylinders stand upon a massive cast iron trunk, which completely encloses the working parts, the whole resting on a substantial cast-iron box section bedplate containing the oil pump, reservoir and filter, to which oil is supplied under pressure to the various working parts.

These engines are exceedingly neat in appearance and occupy the minimum floor space for the power developed, and are designed for use in connection with electric driving, and have been installed in large numbers in many of the leading British power stations where they are called upon to run for many months at a time without a stop.

The governor is of Allen's standard crankshaft type, and is fitted at one end of the crankshaft. It operates a double beat throttle valve situated next to the high-pressure valve chest. Hand gear is also provided by which the speed of the engine can be regulated while running through a considerable range above and below the average speed. A tachometer is fitted in close proximity to this wheel, which indicates the speed of the engine.

Figure 1 shows a three-crank compound high-speed enclosed engine in which the three cylinders are cast separately with their valve chambers.

The stuffing box packings, except where otherwise specified are of special metallic type.

Special care has been devoted by the makers to the question of balancing, the arrangement of the cranks and the disposition of the weights of the various parts being such as to ensure the very least possible amount of vibration. In the larger engines, especially those of the 3-crank type, both compound and triple expansion, special balancing weights are attached to the crankshaft, thereby reducing the unbalanced forces and couples to their least possible values.

Condensers.—For many years Messrs. W. H. Allen, Son & Co., Ltd., have made a specialty of condensing plants, and have built surface condensers together with air-pumps and circulating pumps, arranged to be driven either electrically or by steam, up to the very largest sizes required for modern power plant.

The condenser body and the water box are usually made of cast-iron, the tube-plates of rolled brass and the tubes solid drawn brass and fixed in the tube plates by means of tape packings and screwed brass ferrules.

The circulating water is drawn through the tubes by means of one of the "Conqueror" type centrifugal pumps either electrically or steam-driven, and the condensed steam and air are removed by means of an Allen-Edwards air-pump, which may be a single-cylinder, twin, or triple, according to requirements. Where the condensed water has to be delivered to a hot-well at a considerable height, an extra water force pump is provided for this purpose to relieve the air-pump valves of any water pressure.

The covers of the condenser water box are fitted with inspection doors, through which the water boxes can be cleaned.

The top of the condenser body is also fitted with a soda cock through which soda solution can be admitted to the condenser for the removal of any grease from the surface of the tubes.

Figure 2 shows a steam driven surface condensing equipment arranged to deal with 66,000 lbs. of steam per hour and maintaining a vacuum of 28 in. of mercury, with the barometer at 30 in.

The company also construct jet-condensers of a variety of patterns specially adapted to suit local conditions.

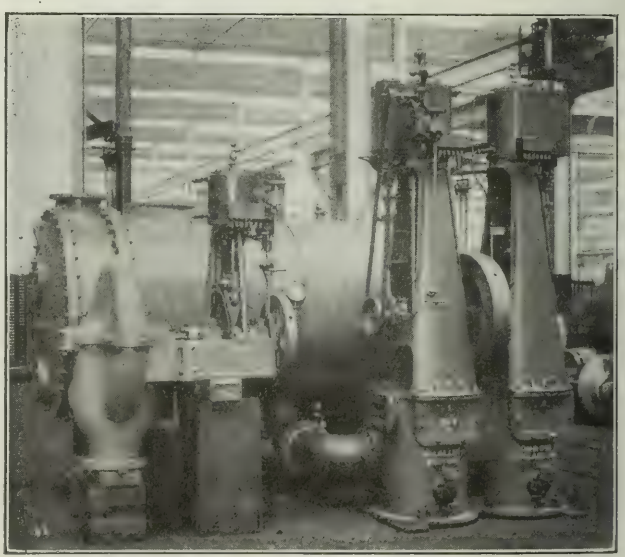


Fig. 2.

Centrifugal Pumps.—These pumps are particularly well adapted for conditions where the plant is required to run for long periods with the minimum of attention, and where limited space only is obtainable. Furthermore, with their large experience, Messrs. Allen have been able to continually improve the design of these pumps so that their efficiency is now brought to the very highest possible figure, while the design of the various parts has been improved along with the production of various improvements in the materials available for construction.

Fig. 3 shows a group of "Conqueror" centrifugal pumps coupled direct to continuous current motors. As will be seen, these pumps are so constructed that the casing is in two halves, one half being readily removable, thus permitting of easy access to the impeller and bearings.

The body and impeller can either be of cast-iron or gun-metal, and the spindle of steel or bronze according to the nature of the water to be dealt with.

All parts are finished to standard gauges and can easily be renewed. The pump is of the very simplest construction throughout, and at the same time has a good efficiency, and as there are no fine clearances the wear on the parts is practically nil, and the pump can consequently run for many years without incurring any costs for repairs or renewals, and is unaffected by water containing solid impurities.

Turbine Pumps.—Figure 4 shows a high-lift turbine pump and motor, the one illustrated being capable of delivering 525 gallons per minute against a head of 1,450 feet. These pumps embody all the latest improvements in turbine pump construction, and great care has been bestowed upon the internal design of the water passages and the selection of materials of construction, producing a pump of the very highest class and giving excellent results.

Owing to the very complete nature of the equipment of the workshops, the workmanship of these pumps is all that can be desired, the whole being finished to standard gauges.

This type of pump finds a large application in connection with mining work as it occupies a very small space and requires practically no attention whatever while running, the bearings being of the self-oiling type.

As these pumps have been designed to give the highest possible efficiency every care has been bestowed upon the finish and materials employed for the internal parts, the impellers and guide blades being constructed of high tension bronze and the spindle of nickel steel. An automatic arrangement is also provided to balance the end thrust upon the impellers and a ball thrust bearing is provided to maintain the shaft in its proper position.

All Allen's centrifugal pumps are adapted for driving either direct by a steam engine or electric motor, and can be arranged for rope or belt driving.

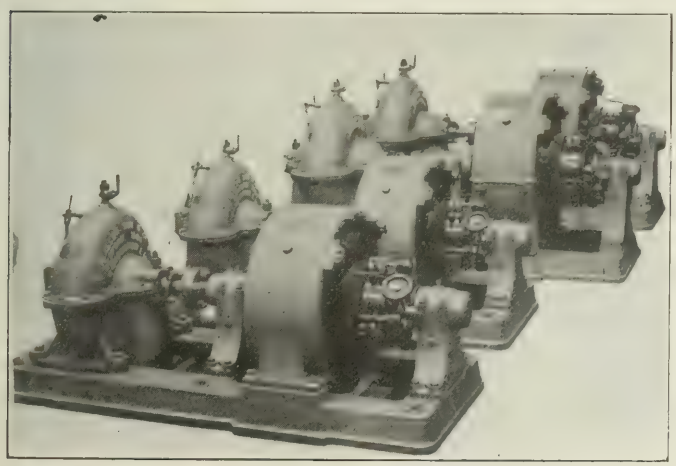


Fig. 3.

When necessary, foot valves can be fitted to the suction pipes or where steam is available an air ejector can be fitted for priming the pump, or the air exhauster may be of a special positive type, which can be driven direct from the pump shaft.

Water Power Turbines.—The increasing number of opportunities which now present themselves for the introduction of water turbines, owing to the opening up of so many districts where suitable supplies of water for driving water turbines are available, has led Messrs. Allen to give great attention to the further development of this class of machinery.

For water turbines up to 400 b.h.p. output Messrs. Allen design and construct their own special type of turbine, but for outputs above 400 b.h.p. and up to 10,000 b.h.p. in one unit, the company have a working agreement with the firm of Piccard Pictet & Co., of Geneva, Switzerland, under which they construct large turbines of their design.

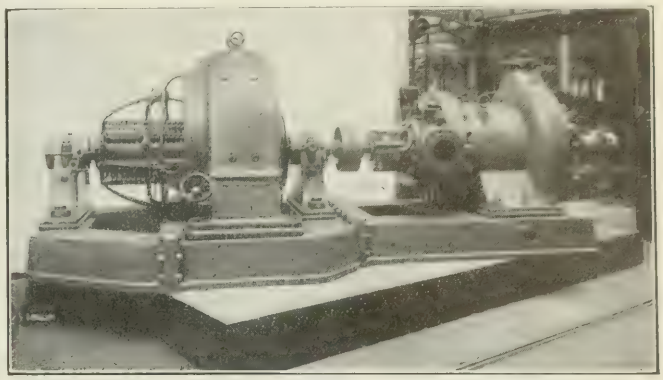


Fig. 4.

As the conditions may require, the turbines may be furnished with either an automatic governor or with regulation by hand only. If an automatic governor is fitted it is usually belt driven from a pulley on the main shaft of the turbine.

The governor, which is of a very sensitive design, by means of special gearing, actuates the regulating blades or shutters in the interior of the turbine, which control the admission of the water to the wheel as the case may be. The latest type of governor proper, which Messrs. Allen supply, is of a design in which the governor weights are suspended entirely by springs, thus eliminating all friction, inseparable from other designs of governors; it is not only a very cheap, but also a most sensitive governor, and is not subject to any wear. The auxiliary governors are either of the hydraulic or mechanical type.

DESIGNING OIL ENGINE PORTS.

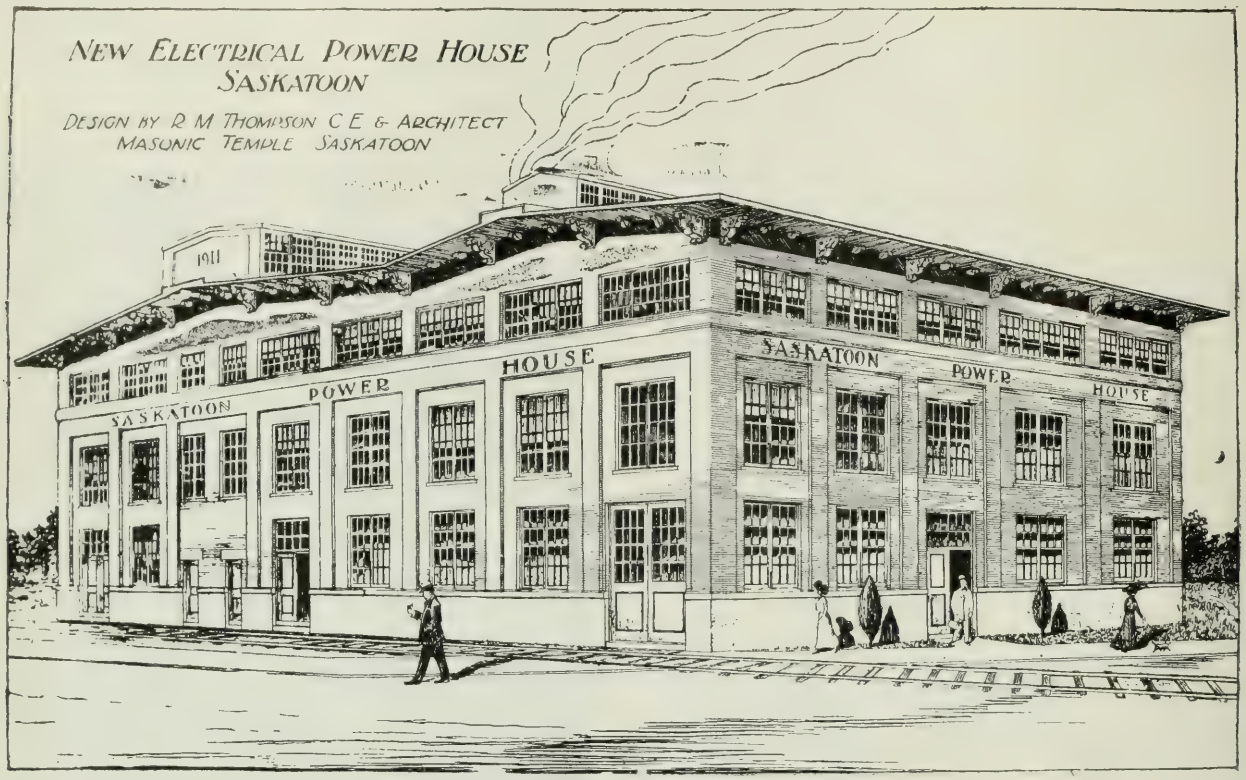
In a recent discussion regarding oil engine ports Mr. Wolcott Remington, designer of the two-cycle Blanchard Oil Engine, stated that in this type of oil engine the height of the exhaust port should be about one-seventh of the stroke of the engine. This, of course, is only general for average speed because the piston speed or the number of revolutions per minute of the engine would have to be taken into consideration in getting at the height of the exhaust port.

The height of the inlet port for average speed would be about half the height of the exhaust port. This is necessary in order to give the exhaust gases sufficient time to escape from the cylinder before the new charge of air starts to enter. These proportions are based on the supposition that the average charge of air will enter at about 5 lbs. pressure.

Mr. Remington is strongly in favor of the two-cycle engine as far as oil engines are concerned, as with the four-cycle type experience has shown that the collection of carbon causes valve cutting and leaky valves with a consequent loss of compression, the real governing factor of the efficiency of an oil engine.

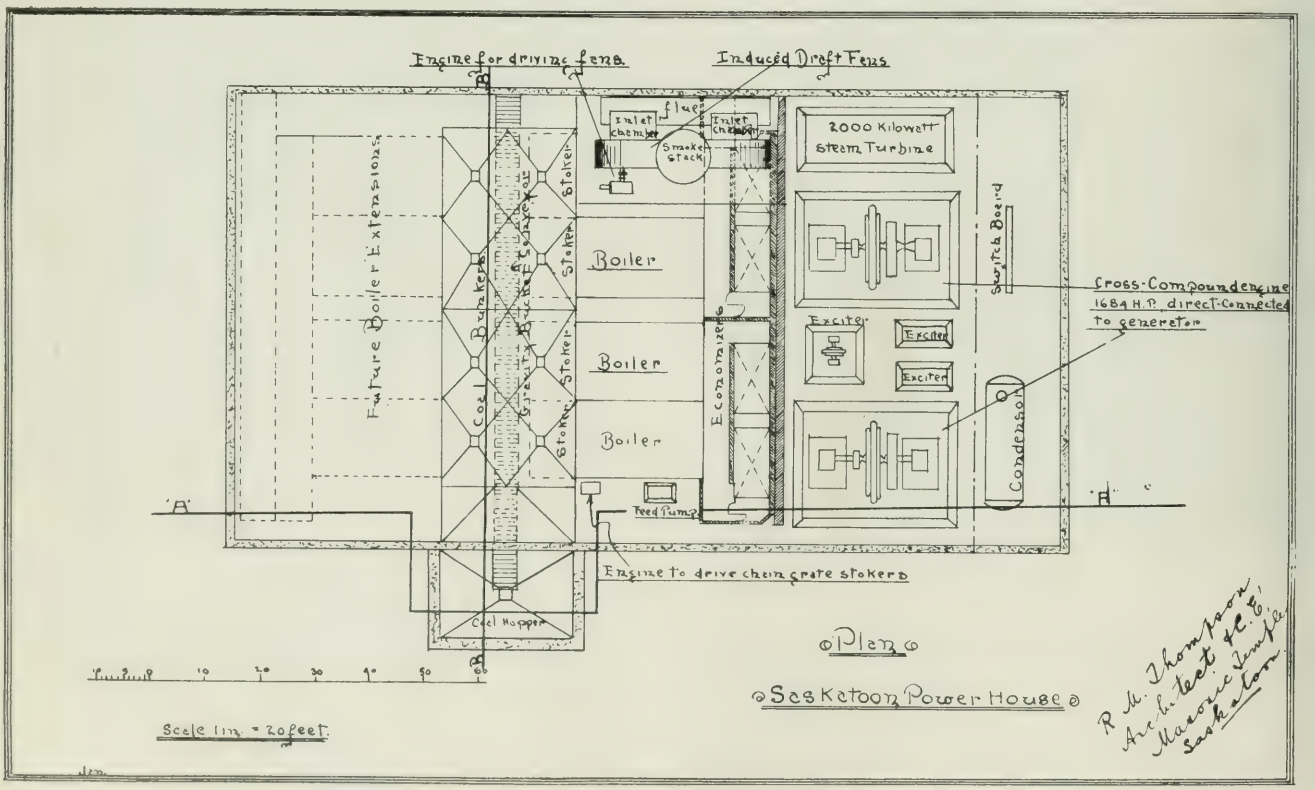
NEW POWER HOUSE AT SASKATOON.

The new power house stands on the corner of Spadina Crescent and Avenue A, Saskatoon, and is one of the show buildings of the city.



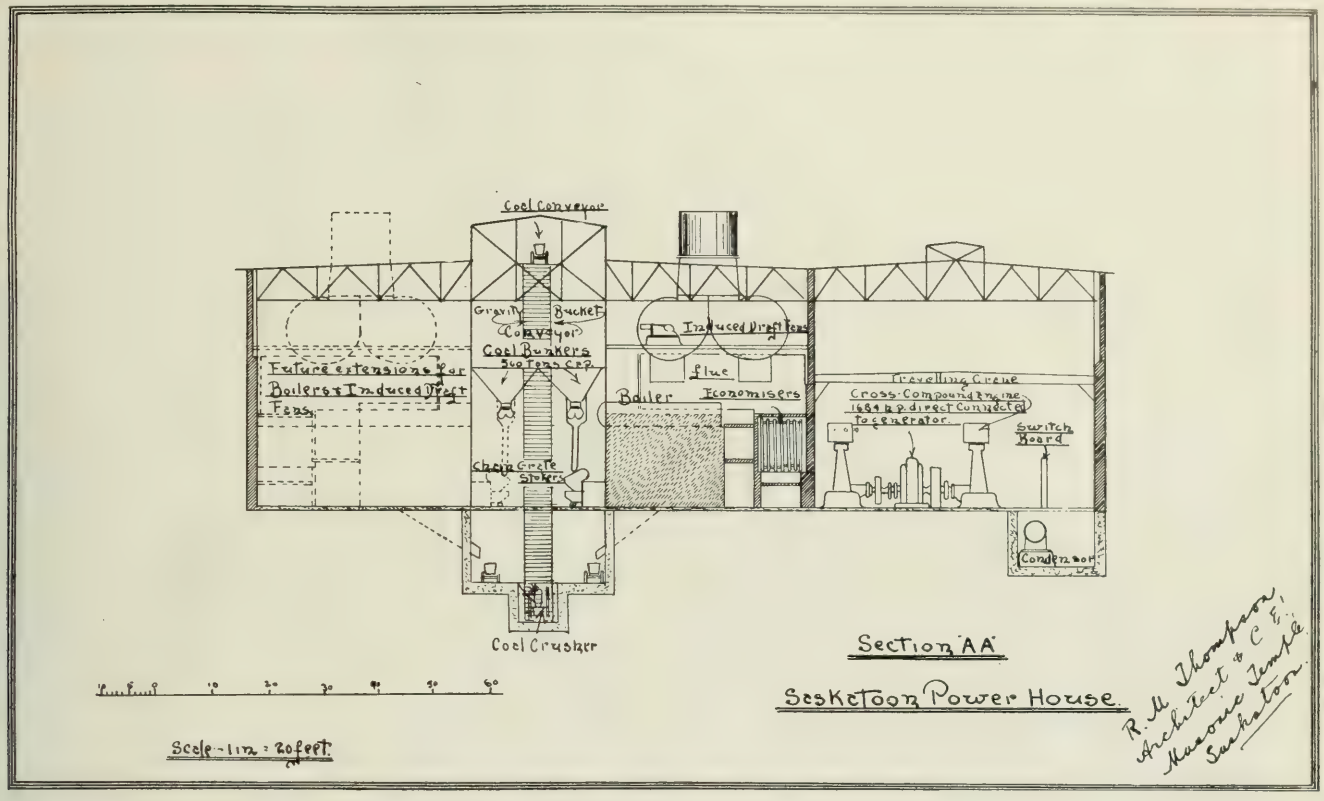
The construction is of steel, brick, and concrete, and is fireproof. The dimensions are 85 by 154 feet, and the walls are 42 feet high; the construction is of the most modern for buildings of this class, and is eminently fitted for the economical and convenient handling of the work. It is designed to admit of the extension of the plant up to 4,000 horse-power before any addition is made to the building, when, if additional space is required, the building will be extended in accordance with plans already in hand.

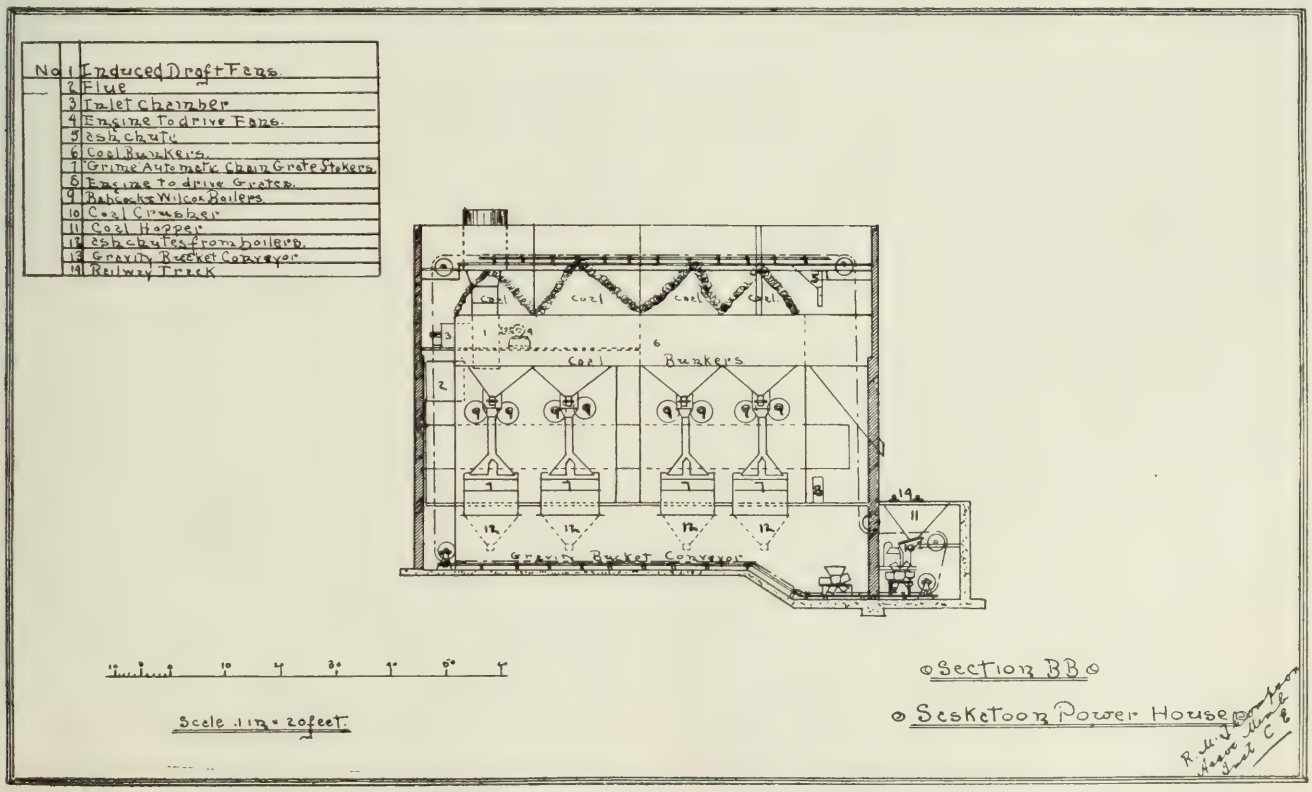
Equipment.—The equipment of the building with suitable machinery is the most important factor. Commencing in the boiler-room, the boiler equipment consists of three double cylinder water tube Babcock and Wilcox boilers, each of a rated capacity of 500 horse-power, but used in conjunction with the economizers, will deliver 650 b.h.p. to the engines, or a total of 2,000 horse-power. These boilers are equipped with Grime automatic chain grate stokers, which



are driven by an independent engine, and feeds the coal as required under the boilers to convey the coal to the stokers.

An elaborate system of coal handling appliances is being installed. The first provision in this connection is the erection of a set of steel coal and ash bunkers, which extend the full width of the building, and are placed immediately above the boiler fronts and stokers. From these bunkers chutes extend down to the hoppers of the stokers, and a steady flow of coal from above supplies the stokers at all times. The overhead bunkers are kept filled by a gravity bucket conveyer, which makes a continuous circuit from the coal hopper outside the building through and under the floor to the back of the building, thence upward and over the coal bunkers back to the hopper. Trips are located at intervals over the bunkers, and any or all of the bunkers can be filled at the will of the operator. Before the coal enters the conveyer, it is crushed to a size not exceeding two inches in a crusher located under the hopper outside of the building. Cars containing coal will be shunted on the track which passes over the hopper, and the coal dumped into same. The





coal ashes are handled in the same manner as the coal by the conveyer, and are elevated into bunkers at the front of the building, from whence they are loaded into cars or wagons by means of chutes.

By this system it will be readily seen that the work is entirely automatic, all manual labor being eliminated in firing the boilers.

The economizers are another distinctive step in the matter of economy in power production. They are set in the rear of the boilers, and all the feed water for the boilers passes through them. In the ordinary method of firing boilers, all the intensely heated gas produced by the combustion of fuel on the grates passes up the smoke stack and is entirely lost. By the use of economizers, the gas and heat is conducted from under the boilers through flues to the economizer chamber, where they are drawn by the induced draft through the economizer section, thereby heating—without further cost—the boiler feed water to a temperature of about 212 degs. F. This water, introduced into the boilers at so high a temperature materially reduces the quantity of coals required to convert the water into steam. The induced draft takes the place of a smoke stack, and the fans are automatically controlled by the steam pressure.

Engine Room.—The engine room is supplied with a traveling crane to facilitate the handling and erection of the heavy machinery. The equipment consists of a 1,684 horsepower Robb-Armstrong Cross compound engine, directly connected to a Canadian General Electric generator of corresponding power and efficiency. The exciter is operated by a direct connected engine, and will give better control of the generator than the belt-driven type.

The new switchboard is of the most modern construction, and besides various other features, has a Tirrell regulator which will keep the voltage steady. When this plant is in full operation, the large engine and generator from the old power plant will be installed in the new building, and used as a part of the equipment.

Large extensions to the plant are being considered for the year with a view of meeting the rapidly expanding demand for current in the city. Five new boilers are now on order and will shortly be installed.

Mr. A. G. Sangster, electrical engineer, designed the mechanical and electrical features of the plant. Mr. R. M. Thompson was the architect for the building.

SASKATCHEWAN FUELS AND GAS.*

By R. O. Wynne-Roberts.

Mr. Cleminsha asked me to act as his substitute tonight, and after rummaging through my notes, I consented to take duties in this capacity. The time, however, has been very limited for researches and inquiries, but the subject is sufficiently important to discuss in a rudimentary manner to commence with. So, to-night I will endeavor to talk on "Saskatchewan Fuel and Gas" in language that shall be, as far as possible, stripped of technical terms. It is a good policy and a desirable thing to utilize local fuel, if it is economical from a financial point of view. This postulation will, no doubt, be accepted by all. According to a report published by the Canadian Department of Mines, there are about 15,000,000,000 tons of lignite in this province. The population to-day is about 500,000, and if every man, woman and child was to consume, say, 10 tons per day there would be enough to last for 6,000 years. I express this fact so as to give you an idea of the quantity that is in this province, because the figure 15,000,000,000 is too great to be appreciated.

There is very little, if any, coal to be found in Saskatchewan, and probably a little peat. There is wood in the northern parts, and a huge pile of straw.

In this province straws of various grains are now lying in great piles about the country, and it has often been suggested that it would be available for conversion into briquets.

Before proceeding further, it is necessary, perhaps, to explain a few terms that will be used. When coal is thrown upon a fire a portion immediately flashes into flame and passes off in the form of vapor and gas. This portion is commonly called volatile matter. The solid fuel remaining is termed coke—it consists largely of carbon, but also contains some material that will not burn. This unburnable portion is the ash, clinker, or refuse that is removed from the grate or ashpit. These three parts of a fuel—volatile matter, carbon and ash—are the most important factors in determining the character of the product in the manufacture of gas, and in its use for heating boilers, etc.

When the coal is converted into gas there are constituents which are combustible and others which are not. For instance, hydrogen, carbon-monoxide, marsh gas, and ethylene are valuable gases, whereas nitrogen, carbon dioxide and oxygen are not so. It is, therefore, possible to judge the value of any gas by the proportion of these gases.

The Canadian standard of comparison of coals is called the split volatile ratio; it is based on the formula

$$\text{Split volatile ratio} = \frac{\text{Fixed carbon } \tfrac{1}{2} \text{ volatile matter}}{\text{Moisture } \tfrac{1}{2} \text{ volatile matter}}$$

According to this standard lignite appears to be less valuable as we trace it from near the Rocky Mountains eastward. Near Edmonton the split volatile ratio is 2.46, at Medicine Hat it is 1.96, Estevan 1.80, Souris River 1.42, and so on.

Lignite at present does not appear to be a popular fuel. A respected friend of mine told me that he gave it to his pigs, as they liked to chew it. There is, however, a limit to this use, for I was told of another farmer in the States who noticed that his pigs liked it, so he pulverized a quantity, which his pigs ate with regrettable results, for they all died. In the course of this talk I hope to show that lignite is valuable for other rational purposes.

In its raw state, lignite unfortunately contains about one-third its weight of water. So, in such cases, when it has to be carried a long distance, one-third of the freight charges are paid for what is not only a useless commodity, but this moisture is a detriment to its use.

Many Saskatchewan lignites do not contain so much water, and this, again, may have a bearing on its use for another process, which I shall explain. Lignite, when exposed to the weather, falls into fragments or slack. This is probably due to the evaporation of the moisture contained in it. If the lignite is stored in dry cellars it not only slakes less badly, but improves in quality. The less moisture it contains the better it is for heating. Lignite, in the condition which it is usually sold, therefore, has two defects, namely, it contains too much moisture, and it slakes badly. Many experiments have been made to improve lignite for heating purposes, first by removing a portion of the water, and secondly, by making it into blocks or briquets.

In Germany, for instance, lignite, or brown coal, has been made into briquets with great success. It has been found that when this fuel contains about 30 per cent. of moisture and a suitable amount of tarry mixture, it will make

* Paper before Regina Society of Arts and Science, March 8th, 1912.

excellent briquets without the use of additional binding composition. So moisture has some advantage in this respect, but in the process of manufacture two-thirds of the water is squeezed out, so it has only 10 per cent., which is about equal to ordinary coal. In Germany a large proportion of the people use lignite briquets as their principal domestic fuel and the industry has grown to be immense. In the United States of America experiments have been carried on by the government, and it has been proved that briquets can be made out of the poorest fuel, but each kind requires to be treated in a particular way. North Dakota lignite possesses similar qualities as Saskatchewan fuel, perhaps it is a little superior. Experiments have been carried on to ascertain what can be made of lignites.

The main reason why lignites are not found to answer in ordinary stoves, or under steam boilers, is because the grates are not designed for that purpose. Lignite, besides containing water, has a low percentage of fixed carbon, and a high proportion of volatile matter. So, when it is used in ordinary grates, it is found to be too flashy, and the draught is often too feeble.

In the first place, we will see what has been achieved by using lignite for steam boiler heating. There are a number of 250 horse-power boilers, sterling water tube type, installed in connection with the Williston irrigation scheme, and one of these boilers was set aside for practical experiments with lignite as fuel. A special furnace of a semi-producer type was built, lignite was fed onto the grate and there converted into gas. The gas then passed through a combustion chamber, where a quantity of hot air was mixed with it, and most of the gaseous combustible was burned. The gas then worked about the tubes and heated the water, on its way out it also heated the air tubes, where the air was heated for the furnace. The fire grate had rooking bars and a quantity of cold air was admitted under the grate bars to keep them cool and to prevent clinker from fusing onto them. There are many interesting points which could be referred to, but I am omitting them. Continuous tests were made, and it was found that the combination of boilers and furnace gave good results with North Dakota lignite. Steam could be made with fuel efficiency of 55 per cent. to 58 per cent. of the heat in the coal, and no difficulty was experienced in obtaining the full capacity of the boiler. The results obtained compared very favorably with those in average plant when the heat available to the boiler is considered.

Another way of using lignites is by making them into briquets. The development of briquet manufacture has been very great during the last few years. On the important coal fields of South Wales, in England, Germany, and the United States, waste fuel, amounting to millions of tons, has been utilized in this manner, with profit to the capitalists and to the communities. The United States Bureau of Mines carried out a large number of experiments. They installed a German machine, designed to make briquets solely by means of high pressure of 14,000 to 28,000 pounds per square inch. This press may be described as a square pipe, into which the crushed lignite is placed and a plunger forces it through. The pipe tapers at the middle and the lignite, as it was forced through, was reduced in size and was polished and smoothed by the heated sides. Lignites from Dakota and other States were experimented upon. Some samples were found to be incapable of being made into satisfactory briquets without some binding material, whilst others proved to be all that could be desired. The conclusions arrived at by the authorities were, that lignite ignited readily, made a hot fire, and burned freely until it was consumed. Little shaking or poking of the fire was necessary to obtain maximum efficiency. The loss of unburned fuel through the grate was from 6 to 8 per cent., which was not excessive, and could be reduced by using suitable grates. In these experiments the lignite was crushed into ⅜ in. diameter or smaller. Dakota lignite was found to be tougher than the rest. It was then dried and afterwards mixed and run into the pressing machine.

These briquets were tested to see how they would stand knocking about and exposure to the weather.

It is stated that lignite briquets can be made for $1.50 per ton; this does not include the cost of the fuel. Among the advantages to be obtained, it is stated that lignite briquets give about 50 per cent. more heat than the raw material; they will stand handling, and will resist weathering much better than the raw fuel. There would be a saving of about 20 per cent. on the freight charges.

Lignite can be made into gas. There are two ways of doing this, namely, by means of the ordinary gas-works plant, and also by means of producers.

Prof. Babcock, of the North Dakota University, carried out interesting experiments in connection with making gas. He had a small plant consisting of a retort bench, condensers, scrubbers, washers, purifiers and holder. These were constructed for the special purpose of seeing what could be done with lignite.

In an ordinary gas-works, the roal is placed in a fire-clay retort, which it like a pipe with one end closed up and the other connected to a pipe to take away the gas. When the retort is sufficiently full a lid is fastened on and no air is admitted. The retort is built in brickwork over a furnace which is heated to a temperature of about 2,200 deg. Fahr. The coal is burned in the hermetically sealed pipe and the smoke has to force its way up through the ascension pipe to the various parts of the work. This, of course, is a very simple description of a gas-making process; it is much more scientific and technical, but for our present purposes I am eliminating everything which might tend to make the process difficult to understand.

When Prof. Babcock was experimenting with lignite he found that it was not necessary to maintain such a high heat, he found 1,200 to 1,400 deg. Fahr. to be ample, so less fuel is required to fire the retort. The smoke that is discharged consists of tar, vapor, and gas. The tar and vapor are removed by means of condensers, scrubbers and washers. The gas is purified by means of lime and other materials, and then it was passed into the holder for use. It was found that the unpurified gas had about two-thirds the value of good coal gas, but when it was purified it was three-quarters as good. Tar and ammonia was also obtained and about half a ton of coke. The gas burned in an ordinary burner without smoking, and could be used like ordinary coal gas, but a greater quantity had to be used to get the same result. One ton of lignite yielded about 11,000 cubic feet of gas, which is about the same as with good gas coal.

The coke obtained, however, was not suitable for use in its ordinary condition, so Mr. Babcock made briquets of it by mixing pitch with it and passing the mixture through a machine. These briquets gave results equal to anthracite which I consider excellent.

With gas producers, air is admitted, so the gas is not of the same quality as when it is made in ordinary gas-works plant. In the suction producer, after a fire has been kindled and the engine started the suction of the engine causes enough gas to be generated as is required, but as lignite has not yet been used to any great extent I will not dwell on this class of producer longer.

The pressure producer, as its name implies, is not dependent on the engine for draught, but air is forced in. These producers are simply cylinders lined with fire brick, into which air and steam is admitted in suitable quantities, and after the gas has been passed through scrubbers and washers to take out the tar, it is passed into a holder for use as and when required.

Many experiments have been made with lignite for gas-making with this type of producer. A 250 horse-power gas producer of this type was installed by the United States Bureau of Mines, and it will be interesting to note what was done. A 235 barke horse-power gas engine was worked and this was connected by belting to a 200 kw. electric generator.

North Dakota, Texas, California, and other lignites were tried and a large number of ordinary coals. I shall take the results obtained with Pennsylvania coals for the purpose of comparison. With Dakota lignite they experienced no difficulty in keeping up full load, and they found that the gas had a calorific value equal to about one-fourth of ordinary coal-gas, that is, it had 145 to 164 B.t.u. per cubic foot. Texas lignite was very satisfactory, and they found that the heat value was greater than that obtained from ordinary coal.

The quantity of lignite used per electric horse-power was as follows:

North Dakota lignite	1.70 to 2.20 lbs.
Texas lignite	1.39 to 1.99 "
California lignite	2.06 "
Pennsylvania coal	1.01 to 1.50 "

The quantity of gas consumed per electric horse-power was:—

Dakota lignite	77.8 to 87.2 cubic feet
Texas lignite	81.3 to 84.8 " "
California lignite	87.7 " "
Pennsylvania coal	81.5 to 103.4 " "

The calorific value of the gas was:—

Dakota	6470 to 7830 B.t.u. per. lb. of dry fuel
Texas	7130 to 8100 " " " "
Pennsylvania	8310 to 13540 " " " "

Generally speaking, lignite used by means of gas producers gave 2½ times the power if used with steam boilers and engines. Furthermore, the experiments showed that low-grade North Dakota lignite developed as much power when converted into gas as did the best Virginia bituminous coal when utilized under steam boilers.

Expressing the results in another way, the efficiency of the entire plant, based on the electric horse-power, made commercially available and the fuel consumed was:—

Dakota lignite	9.2 to 12.7%
Texas lignite	9.9 to 11.9%
Ohio coal	11.1 to 14.3%
Pennsylvania coal	10.8 to 15.0%

So, it will be seen that North Dakota lignite, which is a near relative of Saskatchewan lignite, gave exceedingly good results when converted into producer gas.

There is another type of producer, namely, the down-draft, but this will not permit me continuing the discussion. I may state, however, that the air is admitted at the top and not at the bottom, as in the other producers, and this is for the purpose of burning the tar.

On the basis of the tests made, it will be interesting to note the difference in the various gases made by producers and ordinary gas plant.

Good bituminous coal will yield about 11,000 cubic feet of gas, and almost 1,500 pounds of coke, besides tar and ammonia; the calorific value of the gas is about 650 B.t.u. per cubic foot.

Ordinary bituminous coal converted into producer gas will yield about 120,000 cubic feet, some tar and ammonia, and the calorific value of the gas is about 150 B.t.u. per cubic foot.

Lignite will yield about 11,000 cubic feet of gas, some tar and ammania, and half a ton of coke, which can be made into briquets. The calorific value of the gas is about 500 B.t.u.

Lignite converted into producer gas will yield about 70,000 cubic feet, some tar and ammonia. The calorific value of the gas is about 160 B.t.u. per cubic foot.

Some authorities are sanguine enough to state that in the near future producer gas will be supplied for all purposes at such a rate that might seem incredible. Mr. D. B. Dowling, of the Canadian Geological Survey, in a paper read before the Canadian Mining Institute, wrote: "A town in the west supplied with lignite at from $3.00 to $4.00 per ton should have a producer gas plant to use lignite—heat the houses with gas at ten cents per 1,000, use the gas engine for electric lighting and water supply and run all the factories by the same means of producing power." I am not at present in a position to express opinions on this phase of the subject, but that lignite can be used for various purposes cannot be gainsaid. Producer gas will require larger mains to carry it and larger fittings to consume it than with ordinary coal gas, but when this matter is carefully gone into it may be possible to find compensatory factors.

In conclusion, what will be the advantages of using lignite in the various forms mentioned to-night?

Cheap gas would constitute an excellent attraction to manufacturers; it would also be a great convenience to our womenfolk. Lignite briquets would be cheaper than any other form of fuel, and would be found satisfactory if proper grates were used. Lignite gas would reduce the smoke nuisance. It would be handy for various industrial operations—annealing, japanning, soldering, brazing, drying, evaporating, for stoves, boilers, bakers' ovens, etc. Producer gas is being largely used for brick, lime and cement kilns; gas can be so easily distributed from any centre and to any part. Twelve per cent. of the producers in the United States are operated with lignite. As natural gas cannot be duplicated by any known process, we should make the best possible use of our natural resources of fuel.

Producer gas can be made from wood, sawdust, tan-bark, straw, hay, corn-cobs, and corn-stalks, and even leather scraps, but of course these fuels, with the exception of wood and sawdust, are not yet in extensive use.

The quantity of lignite mined in Saskatchewan appears to increase with the population; for instance in

	Population.	Tons lignite mined.
1891	40,520	20,000
1901	90,564	44,900
1906	257,763	170,582
1911	500,000	200,000 (about)

I wish it to be clearly understood that the remarks made to-night are exceedingly rudimentary. The subject is so full of technicalities that it is difficult to give expression to the essential facts without introducing terms which would require more time to explain than is available this evening. I hope, however, that what has been said will create a desire on behalf of the public for more and fuller information and details. I understand that the government proposes to make a full investigation into this most important matter, and it can be safely said that there is ample room for original experiments and tests.

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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HARBORS ON THE PACIFIC.

The opening of the Panama Canal will herald the dawn of a new era for the west coast of the American continent. A great impetus will be given to the development of the mineral and agricultural resources; in the increased facilities available for marketing products at the great trading places of Europe. The United States recognized the necessity of providing means of transportation for the rapidly developing Western States additional to the transcontinental railway systems in operation now. The completion of the Panama Canal will be the initial realization of the satisfaction of the demand for a shortened and cheaper route to the eastern United States and the European markets.

The United States, appreciating the consequent necessity for adequate shipping facilities as a result of the completion of the canal, are now spending millions of dollars in deepening, enlarging and constructing their harbors on the Pacific coast, so that when the new waterway is ready immediate benefits may be received from its use.

The Canadian Government have been slow to perceive the necessity of immediate action, if Western Canada is to share in the new markets opened by the canal. We are glad to see that they are awakening, however. The report of the Government engineer, Mr. L. Coste, on Victoria harbor has just been published. An abstract of the report will be found in this issue of *The Canadian Engineer*. Mr. Coste recommends a very extensive programme for the development of Victoria harbor, a programme which, if followed, will place the city in a most enviable position for handling its share of the vast traffic which will develop in our Canadian West.

The Government must take steps to follow up the report with prompt action. Every day this work is delayed means increased strength to the American harbors on the Pacific coast. Once the lines of traffic have been laid, it becomes increasingly difficult to change them. To develop our Western provinces and to receive the maximum benefit from the new avenues of transportation, we must spare no exertion. Our harbors on the Pacific coast demand immediate attention if our share of the new prosperity is to be received.

COLUMN DESIGN.

The subject of column design is a very important one, not only from the point of view of safety, but also in the necessity for securing maximum efficiency in labor and material for the manufacturer. In this issue of *The Canadian Engineer* appears an article, entitled "Notes on Column Design." In our opinion the plea of the writer for uniformity in column formulæ is well justified. An examination of the formulæ in common use shows that the majority of designers are not so far apart as is generally supposed. The most commonly employed formula at the present time is that which has been made popular by the American Railway Engineering Association. This conforms tolerably closely to the actual results of tests, and with the extensively used formula of the New York Building Code. The former, and certain formulæ giving similar values, have been justly criticized on the ground of their severity for columns having high values of slenderness ratio.

The remark of the writer concerning the necessity for careful provision for extra amount of flexure in long columns while pertinent, should not be followed to the

extreme. Experimental investigations have shown that the allowable stress on steel columns depends quite as much on the make-up of the section as on the slenderness ratio, and that a short column will not necessarily carry a greater load in pounds per square inch than a column of considerably greater slenderness ratio. It might be remarked that a careful study of actual full-size column tests, made by the engineer members of the Citizens' Committee on the revision of the Toronto Building By-law, showed that a formula very closely approximating that of the New York Building Code fitted the results of tests better than any other, and a working formula was, therefore, proposed which does not differ materially from that formula.

While the practice as followed by the writer, of distinguishing the dead loads and live loads in column design has had very extensive following, it is both inconvenient and liable to lead to trouble. Modern specifications almost universally proportion for dead load and live load by the same formula, making proper allowance for the trying character of the live load by means of an impact formula. The actual simplification of design thus effected is of some importance.

In structural practice on this side of the water, sliding factors of safety are not popular. There is no very good reason why the proper factor of safety for all values of the slenderness ratio cannot be contained in the working formula, and such is the almost universal practice at the present time.

The above comments on this paper are not made in a critical spirit, for the work done and the conclusions arrived at deserve a good deal of attention at the hands of engineers. There is no question that a standard formula for column design (that of the American Railway Engineering Association, or a similar one) would be of great benefit to the designing engineer and the manufacturer. We are glad that the writer has presented his thoughts so clearly in this excellent paper, and we hope that some discussion will arise as a result.

THE RAILWAYS IN BRITISH COLUMBIA.

A vast prospect opens up in British Columbia as the result of the programme outlined in the Provincial Legislature for railway development. Legislation recently enacted provides for the closing link in the new route between the Kootenay and the coast by granting a cash bonus of $10,000 per mile for the continuation of the Kettle River line from Coldwater Junction to Hope. This joins up with the present boundary branch of the Canadian Pacific Railway to Coldwater by the line now under construction from Midway westward and from Penticton eastward. This new route will provide a far shorter and better location than the main line, with the advantage of easier grades.

The Provincial Government also announce the projected acquisition by the Canadian Pacific Railway of the former Great Northern right-of-way in the Kootenay Lake basin of the Slocan. The Canadian Pacific Railway will take over the right-of-way from the syndicate of Kaslo citizens, which took it, with Government backing, from the Great Northern last year. Under the new management the line will be re-built to standard gauge and joined to the Canadian Pacific Railway's Slocan system.

The above announcements, when crystallized in action, will have a great effect in developing the latent resources of British Columbia, as well as in the case of the short route to the coast, introducing the traveller to the developed eastern British Columbia instead of as at present to picturesque mountain scenery as a part of a lengthy journey. The improved shipping facilities should immediately increase the silver-lead and zinc shipments from the Slocan district.

There is no doubt that better railway facilities in British Columbia, combined with the improvement of the harbors and the opening of the Panama Canal, will cause a tremendous influx of capital with the consequent development of the rich resources of the province.

THE FAMINE IN CHINA.

There is a bad famine in China and immediate relief is necessary. Canada, we know will be among the first nations to give much needed assistance. A national movement is being inaugurated and money, wheat and flour will be dispatched to the responsible international committee in China, who will see to its proper distribution. The Canadian railways have promised to help, the leading Canadian milling companies will, if required, grind wheat at cost for shipment to China. Prominent citizens throughout the country will co-operate, and we must have the help and financial assistance of the Dominion Government. Talk is frequent regarding the bonds which exist between nations. Here is an opportunity for us to prove that the talk has a practical and sympathetic phase. From the humane viewpoint, there should be no hesitancy in sending a ship load of wheat, flour, and funds—a national gift from Canada to the famine-stricken Chinese.

Aside from the duty, which is apparent, there are many other good reasons for such action. First, we need the friendship of every nation we can secure. The Oriental labor problem has yet to be solved, and it will be easier to negotiate with an ally. Again, there must be removed from the average Chinese mind the impression that there is only an "America." We should tell the Chinese as a nation that on the North American continent is the great Dominion of Canada, rich in natural resources, and whenever occasion arises, wealthy in practical sympathy.

The suggested action by Canada would have another important bearing. Despite what is said by many diplomats, the Far Eastern situation in its relation to Great Britain and the Empire is by no means removed from the danger zone. The contribution to China, by the principal of the overseas empires should prove of considerable assistance in the future conduct of Empire diplomacy. Then there is the awakening of China to the imperative necessity of the application of modern science to national life. The floods are the cause of the present famine. Floods have proved a national disaster in China time and again. Engineering skill would mitigate, if not abolish altogether, this devastation. Engineering skill would improve the present unsanitary conditions existing in many parts of China and which, with the floods, are responsible for large loss of life. Canadian engineers can take their share of that work in China.

Here then is a worthy appeal to the people of Canada.. Immediate action is necessary. With that object in view, organization and national committees are being formed, the membership of which will probably be made known in a few hours.

EDITORIAL COMMENT.

The annual report of the Temiskaming and Northern Ontario Railway has recently been presented to the Ontario Legislature, and shows a gratifying increase in the total net earnings for the year. The net earnings have increased from $436,130.31 for 1910 to $593,152.69 for 1911, or an increase of about five per cent. The operating expenses have decreased in percentage from 73.2 to 66.4. An appendix to the report is a report from Engineer Ellis, who states that the mouth of the Moose River, on the James Bay, provides the only possible site for a harbor. He adds the opinion that the cost of making the roadstead available for vessels of reasonable draught might not be prohibitive.

* * * *

An inkling of the country's railroad needs is gathered from the statement of Vice-President Bury, of the Canadian Pacific Railway, that the company may spend, shortly, $60,000,000 on an entirely new line of railway from the prairies to the Pacific coast. It was Mr. Bury who recently emphasized the importance of mixed farming in Western Canada as a part solution of the crop movement problem. The growing of wheat, however, will for many years keep ahead of the cult of mixed farming. We cannot tell the Western grower to stop wheat production until railroad mileage, waterways and terminal facilities overtake him. Material and labor, rather than money, appear to be the railroads' trouble. This makes important the work of immigration. In turn, we must remember that railroad labor to-day may not have the same employment to-morrow. While there is need for caution in new tranportation plans, the double tracking of the Canadian Pacific Railway from Winnipeg to the Pacific coast appears to be a necessity. According to Mr. Bury's various calculations, based on the development of all the railways in Western Canada and a proportionate growth of the country, only 40 per cent. of the crop will be moved by the close of navigation this year. This is a problem upon which our governments and tranportation authorities may well concentrate effort.

LETTERS TO THE EDITOR.

Water Powers of Canada.

Sir,—In your issue of March 7th I note an appreciatory editorial respecting the report on Water Powers by L. Denis and A. V. White, recently issued by the Commission of Conservation.

You say: "There is one feature of the conservation question, however, which is lost sight of, and that is the absolute necessity of securing the highest possible economy of water in all water power developments," etc.

Our report not only shows the wasteful use of head, as illustrated by conditions at Niagara Falls, but, in addition, points out the necessity for providing for the possible use of all the power that may be made available at any particular water power site.

This is brought out on page 12 as follows:—

"The regulations respecting waters which are to be set aside for the development of power should be so framed as to require that the preliminary installation of dams and other main works necessary for the control of the waters be made with reference to the possible future development of the full water-power that may be available. For example, suppose a certain waterfall is capable of yielding 10,000 horse-power. If development rights are let to A. for 2,000 horse-power, to B. for 1,000 horse-power, and to C. for, say, 1,000 horse-power., and A., B. and C. are allowed to design and construct their respective works irrespective of each other, or of the possible development of the remaining 6,000 horse-power, then it will probably become quite impracticable to get anything like the remaining 6,000 horse-power because of the damage that would be caused to the plants of A., B. and C. On the other hand, if preliminary works were constructed with a view to utilizing any amount of power up to the full 10,000 horse-power, as occasion demanded, no such contingency as has been supposed could well arise."

James White,
Secretary Commission of Conservation.

* * * *

Lethbridge Sewage Disposal Works.

The Editor:

Sir,—We have read the very interesting account of the new works in course of completion at the above, designed by Mr. Aird Murray, and described in your issue of February 1st, and as makers of the sprinklers and other fittings for the filters and tanks, we would like to add a few lines regarding these sprinklers, which we think would be of interest to your readers.

The three percolating filters are to be worked by our Patent Airlock "Cresset" Revolving Distributor with Canadian Patent Roof Support. The stationary centre column is extended to form what might be described as the tent pole, which extends to the apex of the roof, where the girders converge and are bolted to the lugs on the centre cap. The body of the sprinkler is so built that, by removing adjustable wedges, the double flanged piece in the column can be taken out; this action releases the weight on the ball bearings, so that they may be got at, cleaned and replaced without dismantling the whole of the sprinkler and consequently the roof.

Another valuable advantage which the "Cresset" has over all other makes is its lack of friction when in work owing to the airlock seal. This seal enables the apparatus to revolve with so small a head as 9-inch, and deliver almost any variation in volume required.

We are issuing a new pamphlet, wherein the mechanism of this apparatus is specified, and shall be pleased to send same to any of your readers on application. Yours obediently,

Adams-Hydraulics, Limited.

An interesting bill has been introduced by the Attorney-General of Saskatchewan. The measure provides for the appointment of a Fire Commissioner, whose foremost duty shall be to investigate the origin and circumstances in general connected with every fire which is believed to have been caused by incendiarism or negligence. He may issue subpœnas for the attendance of witnesses at such investigations. Deputies will be appointed throughout the province to furnish the Fire Commissioner with reports on every fire occurring in the various municipalities, where the damage is in excess of $100. They shall also advise him of any suspicious circumstances, and he will then be in a position to institute an investigation. This is most desirable legislation. Manitoba already has a fire commissioner, and Saskatchewan will likely be the next province. Ontario has discussed the matter for many years, but seems little nearer an actual appointment. With an annual fire waste in Canada of more than $20,000,000, every province can well afford to employ a fire marshal or commissioner.

THE PRINCIPLES OF SPECIFICATION AND AGREEMENT WRITING.

By C. R. Young, A.M. Can. Soc. C.E.

(Registered in accordance with the Copyright Act.)

Fifth Article.

GENERAL CLAUSES.—Continued.

The general clauses of the specifications differ from the specific clauses in that they refer to the general office and field relations of the parties rather than to particular operations or details. Where specific regulations are inserted in the general clauses they refer to matters which do not directly enter into the construction of the work but are preliminary or relative to the project. Provisions of this sort would concern such matters as instructions to bidders, security or payment to the Contractor.

There is some difference of opinion as to which of the general provisions of the contract should be incorporated in the specifications under the head of "General Clauses" and which should be reserved for the agreement. It is the writer's opinion that the division should be made on the basis of the uses to which the written contract will be put. The engineering staff, with the exception of the chief engineer or engineer in full charge of the project for the Owner, seldom requires to consult those stipulations concerning the legal or business responsibilities assumed by the Contractor, but any assistant engineer or inspector may require to inform himself respecting any feature of the construction of the work, the payments to be made for it, the direction of field operations, or, in fine, any provision defining the duties and authority of the Contractor or the representatives of the Owner on the work. For this reason, it would appear that all those clauses which concern the normal working of the contract, including such incidents as charges, extras or defective work should go in the specifications while clauses referring to legal or business responsibilities or to abnormal happenings, such as forfeiture of the contract or settlement of disputes, and with which only the original contracting parties and the chief engineer would have to deal, should be placed in the agreement. The specifications then become purely a code of working rules for those who may have to do with the actual prosecution of the work or design or construction, while the agreement becomes a document to which reference need be made only in case of serious disputes, unusual situations or the final settlement.

Of such great variety are the matters treated in the "General Clauses" of the specifications that it is impracticable to mention here more than a part of those which frequently find a place in specifications. The subjects which might advisedly be covered in the "General Clauses" of the specifications forming a part of a typical construction contract, and following the relationship between the specifications and the agreement outlined above, would be as follows:

(1) Definition of Terms.
(2) Contractor's Undertaking.
(3) Plans and Specifications.
(4) Character of Work.
(5) Inspection.
(6) Conduct of Work.
(7) Alterations.
(8) Extra Work.
(9) Duration of Contract.
(10) Powers of the Engineer.
(11) Estimates and Payments.
(12) Security.
(13) Instructions to Bidders.

(1) **Definition of Terms.**—The terms which require to be defined in the "General Clauses" of the specifications are principally those referring to the contracting parties or their representatives, technical terms presumably having been defined in the specific clauses. Thus, the word "Contractor" might be interpreted by an inspector to mean either the general contractor or a subcontractor, unless the particular one meant is explained in the specifications. "Corporation" might, unless limited in its application, refer to a contracting municipal corporation or to the private corporation with which it contracts. If there were more than one municipal corporation involved in the contract, it might refer to any one of them. "Company," "Board," "Commissioners" or any such bodies having mention in the specifications should for the convenience of those whose duty it is to enforce the contract be defined in the specifications and not merely in the agreement, which, indeed, they may never have occasion to examine. So many engineers are associated with a work of any magnitude that the word "Engineer" should be clearly defined. It might mean the Owner's engineer, any consulting engineer who might be retained for special services, a resident engineer or the Contractor's engineer. Definiteness is, therefore, imperative in this matter. "Inspector" should be defined so that, for example, any municipal councillor who chooses cannot hand out instructions to a Contractor under the pretext of being a special inspector.

(2) **Contractor's Undertaking.** — This description of what is to be undertaken by the Contractor does not refer, except perhaps indirectly, to the extent or character of the work which is to be finally delivered up to the Owner, but rather to those things which the Contractor must furnish in order that work of the kind required by the Owner may be secured. He must provide all material, labor, tools and appliances necessary to the completion of the work in accordance with the intention of the contract. It is also advisable to state that the provision of all these things is to be covered by the prices named by the Contractor in his tender, and that no further remuneration may be claimed under this head.

(3) **Plans and Specifications.**—The necessary general provisions relating to plans and specifications may be grouped roughly under the divisions of interpretation, conformity on the part of the Contractor, responsibility for accuracy and feasibility.

The engineer, as the author of the plans and specifications, should have the right of interpreting them, for he should know, better than anyone else, precisely what was meant. To him should be referred for rulings all questions of conflicting and erroneous statements, whether of graphical or written character. In decisions of this sort, it is obvious that the judgments of the engineer should be in strict conformity with the true spirit, meaning and intention of the contract as a whole, and it is the universal custom to specify that this broad view of the contract shall prevail. Errors and omissions in plans or specifications should therefore not be allowed to justify the Contractor in furnishing less than was clearly contemplated in the contract, and he should be called upon to perform all work which may reasonably be inferred as necessary for the complete fulfilment of the spirit of the contract, although certain requirements may, through oversight, not have been stated. In making such a ruling it would manifestly be dishonest for the

engineer to cover up his own carelessness or ignorance by requiring the provision of things which could not be read into the contract by any fair-minded person.

Strict adherence to plans and specifications and to the interpretations placed upon them by the engineer should be required in the contract. This is, of course, presupposed in the undertaking of the work by the Contractor, but it is nevertheless not amiss to point out in the general clauses of the specifications that he will be held rigidly to the written requirements and that he should in no case count upon the leniency of the engineer in releasing him from an onerous obligation.

Responsibility for accuracy of plans and specifications lies, in general, with the party who made them. If the work is done in accordance with the detailed instructions of the engineer and these are found to be erroneous, the Contractor is not liable, unless perhaps he had entered into the absurd agreement to guarantee the engineer's plans and specifications. If the Contractor prepares the detail plans, he, in this case, must assume the responsibility. Approval of these plans by the engineer does not release him, and it is generally so stated in the specifications.

The feasibility of a proposed scheme is in effect guaranteed by the party who proposes it. If the engineer requires a cofferdam to be constructed in a certain manner and it fails, his principal, the Owner, must bear the expense of the failure. If, on the other hand, the Contractor had put forward the proposal, even though the engineer had allowed the work to proceed without protest, the Contractor is responsible. Sometimes, also, the engineer accepts an entire scheme proposed by a Contractor, such as the finishing of new or special materials, machinery or devices, and since the Contractor is by reason of his special experience better acquainted than the engineer with the nature and performance of what he proposes to supply, the former may, by the specifications, be required to guarantee the workability of that part of the construction or equipment provided by him.

(4) **Character of Work.**—Apart from the description in the specific clauses of the specification of the kind of work required in each class, it is well to cover the character of all work in a general way, and in addition to establish the conditions which must be instituted and maintained by the Contractor as an essential of good work. He should be required not only to deliver up to the Owner in the completed structure the best materials and workmanship customarily obtainable, but he should be called upon to provide labor, tools and appliances of a character necessary for the performance of work of this class required. It should further be stipulated that all defective work must be removed and made good at the expense of the Contractor before final approval is granted. The possible refusal of the Contractor to do this should be anticipated by a provision that the Owner may remove such work himself and deduct the cost from any moneys due the Contractor.

(5) **Inspection.**—The fullest privileges of inspection must be retained by the Owner if entire confidence is to be placed in the work. To this end the Contractor should be required to furnish to the selection of the inspector samples of cement, sand, gravel, steel, and all other materials requiring laboratory examination. Sometimes, as in the inspection of structural steel at the mills, the contractor is called upon to provide the necessary testing machines as well. In field inspection, the right of opening up work which has been covered should be secured to the Owner, or his engineer, but if investigation shows such work to have been in accordance with the contract, the Owner should be required to pay for the cost of the opening up. No materials should be allowed in the work which have not had the final approval of the inspector before use. Cement, for example, might be thoroughly satisfactory as tested at the mills or as disclosed by samples taken from the cars, but due to careless handling or storage might be seriously impaired by the time it was incorporated in the work. It is a safe rule to specify, in addition, that all condemned material shall be immediately removed from the site of the work. If allowed to remain, it is surprising how readily it finds its way into the structure.

Many times in the experience of every engineer there arises the embarrasing situation where imperfect work has been approved by an inspector, or while, perhaps, not definitely approved, has been allowed to be put in without protest. In such circumstances the Contractor very naturally takes the position that the work has been done to the satisfaction of the engineer, or to that of his representative, and, therefore, ought not to be replaced. Such an attitude on the part of the Contractor is indefensible, for the reason that conformity with the contract is the standard of acceptance, and if it can be shown at any time before final approval of the work and the taking over of it by the Owner, that the work is not in accordance with the contract, the Owner may require the Contractor to make such alterations as may put it in a condition to satisfy the demands of that instrument. Approval of defective work through oversight or failure to point out faulty construction during its execution does not relieve the Contractor of the responsibility of providing at the close of the work precisely what the Owner called for in the contract.

(6) **Conduct of Work.**—Although, broadly speaking, the engineer is interested only in the character and acceptability of the completed work, he should retain sufficient powers over the Contractor's operations to not only ensure safety, speed and freedom from disputes during construction, but also to require reasonable assurance that the methods of the Contractor will result in ultimate success. At the outset, full protection of the public from accident by means of fences, barriers, covered passageways and lights should be demanded, and if reasonable safeguards for the Contractors own employés are not required, they at least should be required for the employés of other Contractors and for the representatives of the Owner. In addition, the stakes, hubs and marks placed by the engineer or his assistants should be the objects of protection. Work should be allowed to commence only at such places and times as may be mentioned in instructions from the engineer, and the order of prosecution of the work should be under his control. Only in this way would it be possible to have one Contractor conform to the needs of another and to the exigencies of the whole constructional scheme. Direction of the Contractor's forces should be in the hands of a competent and responsible foreman, satisfactory to the engineer. Whatever the character of the foreman may be, however, he should be constituted the official representative of the Contractor in the absence of the latter, and, therefore, qualified to receive instructions from the engineer. Otherwise, an unwilling Contractor might make it exceedingly difficult to deliver disconcerting instructions. In order that completion on time may be facilitated and the engineer's arrangements as a whole safeguarded, he should have the right to order an increase of the Contractor's force if thought necessary, and if the character of the Contractor's employés is objectionable and not suitable for the performance of the class of work required by the contract, the engineer

should be in a position to order their replacement by acceptable men. Order at all times should be obtainable upon direction of the engineer, and the Contractor should be required to so conduct himself and his employees that the interests of other Contractors will not be prejudicially affected.

But while these powers of direction should be secured to the engineer, it is possible to go too far in this respect. Beyond a certain degree of control the Contractor ceases to be an independent Contractor at all, and becomes merely the agent of the Owner. The latter then becomes responsible for the acts of the Contractor, who is under these conditions nothing more than the Owner's "other self." A typical clause of a specification, quoted by Mr. Daniel J. Hauer in the Journal of the American Society of Engineering Contractors for December, 1910, which confers on the engineer powers transforming the Contractor into the agent of the Owner is as follows:—

> "The engineer shall have entire charge of all forces employed under this contract, and shall direct their work and disposition, and shall order such forces increased or diminished as he shall deem expedient."

(7) **Alterations.**—The right to make such alterations or modifications in the plans or specifications as may appear desirable should be conferred on the engineer by the contract. It does not follow that these changes should be executed by the Contractor without extra charge, however, or that they should be considered as covered by the original contract. The limit of magnitude of alterations permissible without involving a modification of the contract should, therefore, be specified.

Where the changes are slight and do not necessitate a very much longer time for the execution of the work as a whole than was originally contemplated, it should be possible for the engineer to order changes, granting to the Contractor, where he thinks proper, extra remuneration or extension of time. If the changes are only of a trifling nature, not involving increased cost or additional time for execution, it should be permissible for the engineer to secure them without any extras or extension of time. In no case should the Contractor be allowed to make a claim for anticipated profits in case of a reduction in the amount of work.

In case extensive alterations are necessary, such, for example, as the relocation of a line of railway through new country, the Contractor should be entitled to demand a change in the contract or a supplementary contract to cover the new conditions. Likewise, if projected changes involve a change in the value of the work of over a certain percentage of the original tender price, the old contract should be altered. Large changes in quantities sometimes affect the unit prices for which work may be done to such an extent that a new contract would be the only fair method of dealing with the situation.

(8) **Extra Work.**—Any excess of the quantity of work as actually executed over the work as defined in the plans and specifications is called extra work. Such work is usually paid for at certain prices stipulated by the Contractor in his tender or fixed by the engineer in the specifications or notice to bidders. In case the work is reduced in quantity it is customary to specify that the Contractor's remuneration shall be diminished in accordance with the reduction in quantities and the unit prices for extras, or perhaps these prices reduced by 10 or 15 per cent.

Perhaps no single consideration pertaining to construction contracts is more provocative of disputes and litigation than the question of extras. The Contractor who has bid too low endeavors to the utmost of his ability to establish claims for extras in the effort to extricate himself from imminent financial loss. As a sort of safeguard against a possible error in his tender the Contractor will, if permitted, name high unit prices for extras, which, while not taken into account in comparing the tenders, may stand him in good stead if he is successful in establishing extras. The practice of the engineer fixing the extras is thus calculated to materially reduce the cost of the work.

In addition to this precaution, the engineer needs to exercise great care in framing all the clauses of the specifications which have any bearing on the question of extras. As a necessary condition to the consideration of any claim for extras, the Contractor should be required to show the written authority of the engineer. It should be distinctly understood in this connection that assent to alterations by the engineer does not constitute a sanction for extras. Some engineers, with good reason, require claims for extras to be presented monthly, so that the question may be investigated while the matter is fresh in mind, and perhaps before the work is rendered wholly inaccessible. Remuneration for extras must be determined by the engineer on the basis of the measured quantities and the prices fixed in the contract. The engineer should not be allowed to fix the prices of extras, since such procedure is illegal. Any work not foreseen in the list of extras inserted in the contract should be covered by Force and Material Account. In this way the Contractor is assured of the cost plus a fair profit, and the engineer may in a measure control the cost by requiring accurate account of the time of workmen and quantities of materials put into such special work.

(9) **Duration of Contract.**—In most contracts time is declared to be of the essence of the agreement, which signifies that there must be a prescribed time for commencement, a time for completion, and perhaps also a specified rate of progress. Without the latter it is difficult for the Owner to cancel the contract on the ground of slowness in the prosecution of the work, since this would only be possible by proving that the Contractor could not by any human means finish on time—manifestly a difficult thing to do. The effect of unusually adverse weather conditions, alterations and delays on the time of completion should be definitely covered. Slight alterations, not entailing extra work, should not entitle the Contractor to an exension of time unless the engineer judges such to be warranted. Where the Owner suspends or delays the work, it may be only common justice to not only grant an extension of time equal to the delay, but some extra allowance or compensation for the loss attending the tie-up of the Contractor's plant and organization during the delay, and for the interference with subsequent work to be undertaken by the Contractor.

(10) **Powers of the Engineer.**—If the Owner is to be assured of reasonable progress and despatch in the work, there must be one individual in supreme control, and that person the engineer. Questions of a purely business character might be satisfactorily settled by others, but all matters involving technical details should be subject to the final decision of the engineer in charge, who, for convenience, is usually the engineer who prepared the plans and specifications. Only an engineer, or his representatives, should, for example, be allowed to interpret the plans and specifications, or to pass on questions of measurement, classification or quality, or to make alterations or order extras. No one but an engineer should be given the power of general direction

of the work with certain rights over even the forces of the Contractor.

Upon the award of the contract the engineer ceases to be merely the professional adviser of the Owner, and takes upon himself new and onerous duties. He must then not only direct the work, but interpret and enforce the contract and become to a large extent the sole arbitrator of most of the disputes which are likely to arise between the two contracting parties. The anomaly of the engineer occupying this judicial position while being in the pay of one of the parties to the contract has frequently been pointed out, but no one has yet devised a better arrangement. Probably no better evidence of its practicability and of the tact and success with which the engineer has on the whole filled this dual and manifestly difficult position is needed than the fact that the practice of giving large judicial powers to the engineer still continues to be almost universal. Of course, if an engineer were to adopt the attitude of uncompromising partisanship on all matters, or seek to conceal his own errors and omissions under cover of his authority as engineer, great hardship might result to the Contractor, but if he is honorable and firm enough to be fair at all costs there is no reason why his interpretatioon of the contract should not be satisfactory to both parties.

(11) **Estimates and Payments.**—As a guidance to the engineering staff in general, it is desirable to incorporate in the specifications the provisions respecting estimates and payments. Usually, progress estimates of an approximate character are granted to the Contractor every month, and upon presentation of this to the proper authorities he is entitled to receive payment for the value of the work done during the previous month, less a certain drawback. The drawback, which runs from 10 to 20 per cent., constitutes a deposit to secure the Owner against loss due to defective work or other breaches of the contract. The percentage should not be large, and is preferably less than 20 per cent., since the tying-up of a large amount of the Contractor's money results in higher bids than would otherwise obtain. After a certain sum, depending on the size and character of the work, has been held back, it is unnecessary and undesirable to continue the deduction of the percentage, and the amounts due the Contractor on progress estimates should then be paid in full as they fall due. The final estimate is usually deferred till about one month after the work has been completed to the satisfaction of the engineer, during which time liens and other claims against the Contractor may be filed. Having then deducted all sums due the Owner or to creditors of the Contractor whose claims had been formally registered, the Owner makes the final payment in accordance with the estimate of the engineer.

(12) **Security.**—To ensure that the Contractor will formally enter into a contract if the work is awarded to him, it is customary to require either a deposit cheque or a guarantee from a surety company or a private individual. The amount of the cheque is usually about 5 per cent. of the tender price on contracts up to one thousand dollars and 2½ per cent. on contracts over that amount. If the bidder be unsuccessful, his cheque should be returned forthwith, but if successful, it is retained until he has formally entered into a contract with the Owner. While the deposit cheque is most commonly required, a guarantee is much less objectionable from the Contractor's point of view, as it obviates the tying-up of his money, which, if he had many bids outstanding at any one time, might be very extensive.

On important work, and generally on work of a public character, the Contractor is required to submit a bond for the faithful performance of the contract. This is preferably supplied by a surety company rather than an individual, since the status and solvency of the latter is sometimes difficult to prove. In any event, the bond should be drawn in such a way as to allow slight changes in the contract without releasing the surety.

(13) **Instructions to Bidders.**—The information which is incorporated in the "Notice to Bidders" should also be inserted in the specifications, and generally in somewhat greater detail. It is excellent practice to require all bids to be made on standard forms of tender supplied by the engineer. In this way irregular bids, errors and omissions are frequently avoided. Matters to which the attention of the bidder should be directed by this section of the specifications are the sealing and marking of bids; delivery to a specified address by a certain time; portions of the work open to tender of any one bidder; provision of the prescribed security; reservation of right to reject any or all bids; and items for which prices are to be quoted in the tender.

The series of articles by Mr. C. R. Young on **"Principles of Specification and Agreement Writing"** will soon be complete, and may then be obtained in pamphlet form from *The Canadian Engineer*. Orders will be received at any time.

MUNICIPAL WORK IN BASSANO, ALTA.

By-laws providing for an expenditure of two hundred thousand dollars upon waterworks, sewers, concrete walks, street grading and city hall are to be submitted to the ratepayers of Bassano, Alta., immediately. Such was the decision of the Bassano town council at a recent meeting.

With a view to aiding the town in the floating of their debentures, owners of subdivision property adjoining the present town limits voluntarily requested the council to extend the borders of the town, by taking in their property. This will be done immediately, and with the result that Bassano's assessment will immediately jump close to the two-million-dollar mark.

The source of water supply will be the Bow River, at a point 3½ miles southwest of Bassano, and in the vicinity of the C.P.R. irrigation dam, a large stand-pipe to be erected near the intake. The total cost of the water system, according to the present estimate, will be $83,391.10, while the cost of the sewer system will be in the neighborhood of $60,000. In the latter estimate provision has been made for disposal works to be located about two miles to the east of the town.

The main outfall sewer is to be constructed with a capacity large enough to serve a town of ten to fifteen thousand people.

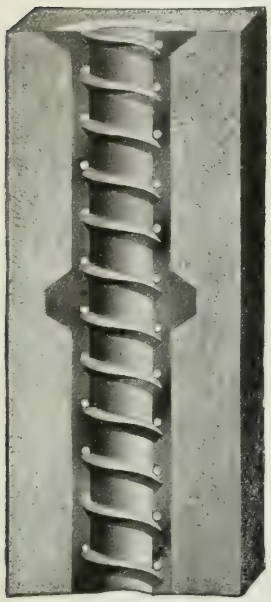
The by-law for the new $25,000 city hall, together with the $25,000 by-law for concrete sidewalks and street grading will be submitted at the same time as the water and sewer by-laws, and not later than April 6th. Immediately upon ratification by the ratepayers, work will be started and rushed to completion. The citizens feel confident that both water and sewer system will be completed and in operation early this fall.

REINFORCED CONCRETE TIES.

A substitute for the wooden railway tie has been long looked for. The Universal Concrete Tie Company, Whitney-Central Building, New Orleans, have furnished us with the following information concerning their new reinforced concrete tie. This will no doubt be of interest to everyone who is in touch with the tie question.

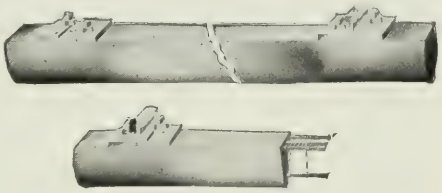
This company, which has now organized and opened its principal offices in New Orleans, is the outcome of fifteen years of strenuous labors on the part of the inventor of the well-known reinforced concrete tie and fastening or spiking device bearing his name. It is a coincidence that these ties should have been tried out and after more than five years of practical use under heaviest traffic conditions, been cordially recommended by the roads using them, and that a company has been formed to introduce them at the time when the eyes of the railroad world are seeking light on this subject. At their last meeting, the American Railway Engineering and Maintenance of Way Association apointed a special committee to investigate and make concise recommendations for next year's work, on a substitute for wooden ties. The necessity for a substitute for wood ties is conceded.

LATERAL SECTION OF REINFORCED SOCKET IMBEDDED IN CONCRETE TIE



The fundamental objection to the concrete tie is its want of resiliency. This criticism, however, is overcome in the construction and use of this reinforced concrete tie, which cushions the load effectively. This is proven by four to six years use of these ties under heavy traffic conditions on various trunk lines.

These ties are built upon the same principle as the best concrete construction, being reinforced by heavy corrugated steel bars, so tied together as to form a truss unit. They are moulded in specially designed moulds, and thoroughly matured before used, and with proper care in selecting and mixing the ingredients, permanency is assured. The rounded edges of the base of these ties, minimizes the weight and eliminates breakage of unprotected edges in handling, while the "V" shaped centres of base insure solidity in track, overcomes the vibration of motion, prevents sliding or slewing of track, and entirely eliminates centre binding, so common in all other ties.



These ties can be made at points along the track where needed, thus obviating the handling except on push cars, and by common labor of the section, when not otherwise employed. This must always be under proper supervision.

The weight of ties varies according to size, i.e., from 375 lbs. for ordinary roadbeds, to 450 lbs. for heaviest traffic conditions under trunk lines, while in terminals and grade crossings larger are used. Owing to their greater bed and face area, 2,600 of these ties will replace 3,000 wood ties to the mile under maximum traffic conditions.

The company recommend the 9 ft. 10 in. face tie for all terminal construction where traffic conditions demand permanency, and where, as in tunnels and causeways, the cost of changes always reaches extravagant figures and handicaps traffic. The hardwood cushions 2 in. by 14 in. by the width of the tie, are readily interchangeable by one man sitting on end of tie, and without interference with traffic, simply removing the two screw spikes which pass through holes in block or cushion, into reinforced babbit metal sockets previously imbedded in ties when moulded.

One company which has been using these ties for nearly six years states that the cushions, though regularly examined, are perfectly sound though "checked," and that spiking devices have never needed tightening and are holding rails firmly.

Experience under varying traffic conditions has proven that rails on these ties remain true to gauge, and that the track cannot spread since spiking device does not work loose.

This spiking device consists of a screw spike of varying lengths and diameter, according to its uses, which enters a reinforced non-corrosive socket imbedded into the concrete. This is suitable likewise for all kinds of cement construction, such as buildings, viaducts, street railways, etc.

THE CONFLAGRATION HAZARD.

With the idea of making impossible the repetition of such terrible catastrophes as those which have recently overtaken Baltimore, San Francisco, Bangor, Chelsea, and other unfortunate places, considerable attention has been given toward the development of fire breaks or stops which would make virtually impossible the repetition of such a disaster. Among the ideas which have met with expert approval might be mentioned the erection of solid lines of heavy fireproof buildings, roughly in the form of a Maltese cross, thus dividing the total area into sections separated by these massive bulwarks. This scheme, however, does not provide against the carrying of embers by a high wind to a long distance in advance of a conflagration.

The only apparent complete solution of the situation lies in equipping the principal buildings, certainly within the congested area, in such a manner that it will be virtually impossible for fire to obtain hold upon them, and thus advance another step in its progress of destruction. There are two general methods by which this may be done, but for most perfect protection they should be jointly adopted.

For fighting a fire on the inside of a building it is absolutely essential for best results that the building be equipped with an approved form of automatic sprinkler which, opening as soon as the temperature caused by the fire reaches a certain predetermined point, will flood that fire and thus automatically put it out. The secondary protection, which would come into play only when a conflagration is in progress or threatened, is a system of open sprinklers on the outside of the building, located one above each window or other exposed opening, and operated by means of a valve at some distance, turning water into the pipes and surrounding the building with a veritable curtain of water through which the fire cannot pass.

A splendid instance of this duplicate form of protection was in evidence at the Baltimore fire in the premises of the O'Neill Department Store. This building was equipped both inside and out as above described, the outside sprinklers covering no less than 98 windows in the six stories. It was directly in the path of the fire and was attacked by flames

which practically enveloped it, leaping more than 15 feet above the elevated sprinkler tank, the top of which is 30 feet above the roof. The cover of this tank was destroyed, while the tank and the timbers on which it rested were so badly damaged as to necessitate replacement. They were saved from total destruction, however, by blocking the overflow pipe and keeping water running in the filling pipe, thus overflowing the tank and keeping it wet. The cornice of the building was on fire a number of times, but four Grinnell automatic sprinklers in the attic prevented the fire from entering. The freight elevator caught fire, but two sprinklers at the top checked it here. The open sprinklers over the windows were put in operation fifteen minutes before the flames attacked the building, and such was the value of the screen thus formed that the store was open for business again two days after the fire. Thus the sprinkler saved not only the building and contents, but other buildings which, protected by this screen, were shielded from the direct force of the flames.

An interesting sidelight on this lies in the fact that a modern 11-story "fireproof" building directly across the street, equally exposed but not protected by sprinklers, was completely gutted.

NEW STEAMER FOR VANCOUVER.

A new twin-screw steamer the "Chelohsin" has been built to the order of the Union Steamship Company, of Vancouver, by the Dublin Dockyard Company, Dublin, and is described in a recent issue of Engineering. She is intended for the owners' passenger and light-freight service in the protected waters of British Columbia.

The dimensions of the vessel are 175 ft. long between perpendiculars, with a beam of no less than 35 ft., which was necessitated by the vessel's great height, there being four decks devoted to passenger accommodation, etc. She has been built under survey of the British Board of Trade and the British Corporation, and is specially strengthened with plating, doubled forward, to resist the impact of floating timber, and, for the same reason, aft, the propeller shafts are outwardly protected by bossing the shell, and the propellers are of strong section cast steel. A specially heavy belting surrounds the vessel, and the anchors are drawn up into recessed hawse-pipes forward so as to be under the flush of the shell plating, thus preventing damage to other vessels coming alongside. The hull has also been built of very stiff construction, all the four decks being completely plated with steel, and the whole bound together by a system of pillaring, the efficacy of which was found at the trials, which took place in rough weather, for there was then a total absence of the annoying vibration associated with high speed engines.

The first-class passenger accommodation is very comfortable, nearly all the state-rooms having only two berths on the awning and shade-decks. They are finished in oak, and in some of them both hot and cold water are laid on. Fourteen of the state-rooms have, in addition to the two open berths, a folding cabinet-bed on the American principle. The dining-room is situated on the main deck, with a companion-way to the awning-deck. It is square in shape and will accommodate 60 passengers, the tables being arranged for small parties of four, six, or larger numbers. The pantry and the galley are adjacent.

The ladies' saloon is on the awning-deck aft, attached to it being a tea-room and a reading-room, and also a ladies' retiring-room with toilet arrangements. There is also what is called a conversation-room on the awning-deck immediately forward of the range of state-rooms. It is spacious and has large sliding windows all round, through which the scenery, which is in many places very fine, may be viewed. This room also forms the principal entrance hall. The smoking-room is on the shade-deck forward of the funnel casing, and in this again the windows are of the sliding type. In front of the smoking-room is the chart-room, and in front of that the wheel-house. The second-class accommodation and that for the deck passengers are situated on the lower decks forward. The comfort and the convenience of the passengers has been well considered, there being a hot-water system, steam-heating system, and a complete electrical installation.

The propelling machinery has been supplied by Messrs. MacColl & Company, of Belfast, and consists of two sets of balanced-crank triple-expansion engines, supplied with steam at 185 lb. pressure per sq. in. from two specially large boilers, designed for burning inferior coal. The auxiliary machinery comprises centrifugal, circulating, feed, bilge, and sanitary pumps, evaporator, ash-ejector, etc.

Before leaving Belfast, the vessel ran her trials on the new measured mile in Belfast Lough, and obtained a speed of 14.29 knots in service conditions, and fully 13 knots with 300 tons of dead-weight on board, both speeds being in excess of that guaranteed, although the weather was boisterous at the time. The vessel was built to the specification of Mr. James Maxton, consulting engineer, Belfast, under whose supervision the trials were carried out.

The Chelohsin has made an excellent maiden-voyage, the long passage from Belfast to Vancouver being made in 72 days; and the vessel has not suffered in the least from her ocean trip. To economize coal on the voyage, steam was generated by one boiler only.

BUILD THE GEORGIAN BAY CANAL.

The following resolution was passed by the Ontario Associated Boards of Trade recently:—

"That the reports of engineers on the surveying and estimating for the Georgian Bay Canal show that the section from Georgia Bay to Lake Nipissing, through the French River, is comparatively easy of construction and not of excessive cost:

"That the making navigable of the French River would throw open to water competition in rates all that section of Northern Ontario tributary to Lake Nipissing, and would give the Temiskaming and Northern Ontario Railway, which serves the farming sections of the Temiskaming district, the lake port considered so desirable to the successful operation of that railway;

"That the Canadian Pacific and Canadian Northern Railways, serving what might be called the western portion of the clay belt, the farming section of the Sturgeon Falls district, centring as they do with the Grand Trunk Railway and T. and N.O. Railways at North Bay, would have the advantage of a lake port at North Bay and that this would work to the advantage of all lines of private enterprise that might be entered into in the north country;

"That the construction of the canal would develop the water powers of the French River, which are now held back from development by the Dominion Government because of the possible construction of the Georgian Bay Canal, and, therefore, would make available electrical energy to be used in manufacturing, mining or any enterprise in which power is used;

"Therefore, that the making navigable of this river is a most important factor in the upbuilding and development of all the eastern portion of Northern Ontario."

Metallurgical Comment

T. R. LOUDON, B.A.Sc.

Correspondence and Discussion Invited

RE-ROLLED RAIL BARS FOR CONCRETE REINFORCING.

Quite recently in the pages of one of our contemporaries, there appeared a discussion on the question of the advisability of using for the purpose of reinforcing concrete, bars that have been re-rolled from old rails. Some of the statements made in this discussion were, to say the least, rather sweeping and could hardly have been made with a full knowledge of facts.

At the outset, it is to be clearly understood that **the following is not a discussion as to the relative merits of low and high carbon steel for reinforcing concrete.** It is merely intended to point out a few facts that have come under the writer's observation and which it will be seen must necessarily have a great effect on the question as to the desirability of re-rolled rail bars.

Before discussing the re-rolling of rails, the writer would take exception to the following statement that appeared in the referred to articles and which is apparently given as a reason why re-rolled rail bars are as well made as other bars rolled from billets:

"It is a matter of common rumor, if not common knowledge, that the scabbed, piped and otherwise defective billets are used for rolling into reinforcing bars; also, in many cases, the crop ends from the ingot, rejected as not being good enough for a rail, are so rolled."

Such a statement, if true, would warrant a deep searching investigation—if true; but, the reader will see that the matter is one of "common rumor if not one of common knowledge." To the man who is accustomed to think, "common rumor" is a very dangerous and untrustworthy source of information. To the practical man, however, portions of the statement contain a refutation of their truth. It is a matter of practical knowledge that to roll steel containing a "pipe" means that the final metal will contain this same cavity in compressed and elongated form. The surfaces of the cavity do not weld together under rolling for the very good reason that they are generally badly oxidized. One can readily imagine the form of concrete bar resulting from this "piped" billet or from the rail crop end which is rejected because it contains the "pipe" of the ingot from which it is cut. It cannot be said with absolute certainty that no "piped" billets are ever rolled into concrete bars, just as it cannot be said that no "piped" rails are ever put out in service even after the greatest precautions; but, what is more to the point, it can be said that **great precautions are taken to prevent such a thing happening.**

To come back to the re-rolling question, it must be admitted that the proper re-rolling of a rail into a smaller rail section does give an extremely good and serviceable rail **provided the original rail was free from defects.** Re-rolling is not going to cover up those defects. On the contrary, it has been the writer's experience that the re-rolling in diagonal passes tends to uncover such defects as hidden "pipes," seams, etc.; so that the final inspection very easily eliminates the undesirable rails. This fact is used as an argument that the same thing will happen in re-rolling a rail into bar sections. To a very limited extent, this may be true. As far as the sound steel itself is concerned, the re-rolling certainly tends to give it a higher elastic limit and ultimate strength; so that, provided an engineer favors the use of "high elastic limit" steel, one apperently gets perfection in this product. But we must stop to consider that if the rail has a defect to begin with, say a small undiscernible open seam, this flaw will not be readily detected in the final bar. It is comparatively easy to inspect re-rolled rail sections; but, one would have to go over each foot of a re-rolled rail bar with extreme care in order to detect some of the fine seams that the writer has seen in these bars as resulting from a defect in the original rail. Supposing, however, for the sake of argument, that it is admitted that all the original rails are free from defects, there still exists a fact that must be recognized if one uses the re-rolled product.

In the table below the writer gives some analyses from actual rails that were selected at random from a pile of rails that had been re-rolled:

	Rail No. 1	No. 2	No. 3	No. 4
Carbon	.29	.31	.05	.51

The wide range in carbon content of these rails is at once apparent. The tests of the re-rolled product showed the consequent variation in strength that one would expect. But, it may be said that this variation is abnormal; rails are manufactured to-day under a very definite chemical specification. Quite true; but, if one will take the trouble to look up these specifications, such as those of the American Society Testing Materials, it will be found that in Bessemer rails there is a range of from .35 to .55 carbon for rails varying in size from 50 to 100 lb. section (the carbon content being given for the various sizes of rails); and, in open hearth rails, the range for the same rail sections is from .46 to .75 carbon. As rails used for re-rolling are of all sizes, it would seem to follow that one would get bars with varying strengths; **certainly the bars would not be all alike as far as carbon is concerned.** To such an argument as this, the answer might be that re-rolling mills sort the rails into piles according to section, etc.; but, it is seen that even if this is done, the rails may some of them be Bessemer and others Open Hearth, and a glance at specifications shows that, say for 80 lb. rails, Open Hearth shall be between .52 and .65, and Bessemer between .4 and .5 carbon, which gives a range of from .4 to .65 in 80 lb. rails piled without taking into account whether they were Open Hearth or Bessemer rails. Such argument might go on indefinitely. It is fact with which we are concerned.

It will be noticed that in the given analyses, one of the rails showed merely .05 carbon. In fact, this was an old wrought iron rail. The point is that these old rails (not necessarily wrought iron) are finding their way to the re-rolling mills, and with them there is absolutely no definite guarantee of carbon content, so that the final product is necessarily a variety. It is beside the question to say that the steel in rails is all of good tested quality; that these old rails are very good steel, etc. The steel is of good tested quality for rails, but, it does not necessarily follow that it will give an even quality of steel for bars.

If engineers wish to use steel whose carbon content is likely to vary widely, all well and good. They do so knowing that the steel they are using may have a wide range of strength. **This fact must be recognized and**

given its due place, even if, as someone has suggested, "Oh well, most of the steel is good; but, now and again soft or very hard bars creep in."

STEEL WHEELS.*

Chas. C. Bacon, Jr.

The wheel committee of the Master Car Builders' Association was instructed by the executive committee, last June, to consider the designs and specifications for steel wheels and to report at the convention to be held this coming June. The wheel committee held a meeting about two months ago at which were present, by invitation, representatives of the solid steel wheel manufacturers. Upon learning that the subject of specifications covering solid steel wheels had been under consideration for upwards of two years by a special committee of the American Society for Testing Materials, the M. C. B. committee very promptly determined to accept an invitation which was extended to have representation on that committee. This latter committee is well qualified to handle this important item intelligently, being composed of representatives of the manufacturers and of the railways which have had the longest and most extensive experience with solid steel wheels. It is but right

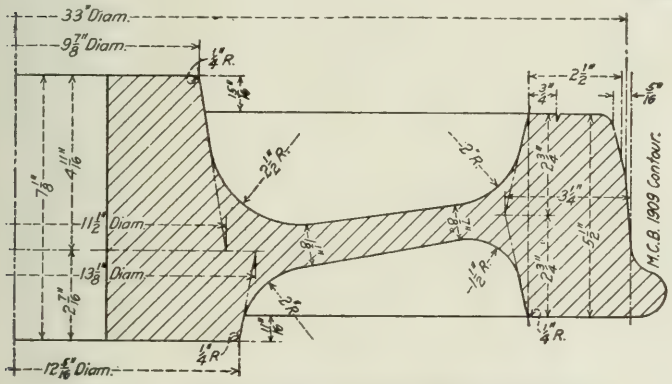


Fig. 1.—Typical Design of Solid Steel Engine Truck Wheel.

and proper that the question of design be thrown open to all, so that there may be full expression of opinion, and so that the manufacturers and the railways will reach agreements, or standards, at the earliest possible moment. The object of this paper is to place before you a list of twenty-one designs of solid steel wheels which long experience and careful study would seem to indicate are adequate standards in connection with more than ninety per cent. of the requirements of the railways of the United States to-day, and which would soon cover the other ten per cent. if railways would give attention to some points in connection with co-ordinate equipment; also to further place before you certain reasons why a study of the subject has convinced me that a total of eleven of these designs are all that are desirable or required.

A 33-in. steel engine truck wheel is shown in Fig. 1, which is representative of the other designs for different diameters of this type of wheel. Fig. 2 shows the design for a 33-in. tender, passenger car and freight car wheel. The salient point of difference between these two general classes is that wheels for engine trucks require inside hub faces of large diameter to provide adequate bearing surface. A total of eleven designs which I think are all that are desirable are, for engine trucks, 28½ in., 30 in., 33 in., and 36 in. For freight cars, tenders and passenger train cars, 28 in., 30 in., 33 in. (two designs) 36 in. (two designs) and 38 in.

One of the reasons for increasing the number of designs of wheels for engine trucks above the four above noted is that of the diameter of the inside face of the hub. It has long been considered by prominent roads, which have placed may thousands of solid steel wheels in engine truck service, that this dimension should properly be 12 5/16 in., but recently several large companies have called for engine truck wheels with inside hub faces of either 13 in. or 14 in.; in fact, one large system has issued a sheet setting forth that this dimension shall be either 11 in., 12 in., 13 in., 13½ in., or 14 in., under certain conditions. Ninety-five per cent. of the solid steel wheels which are in engine truck service in the United States to-day have 12 5/16 in. diameter of inside hub face. This dimension is standard with the roads which have had the longest and most extensive experience with solid steel wheels of this type and I am told that it has proved to be a proper and satisfactory dimension. The cost of manufacturing solid steel wheels, and therefore the price to the railways, is largely a question of the number of wheels produced per type, and this being the case it seems most important—particularly as regards engine truck

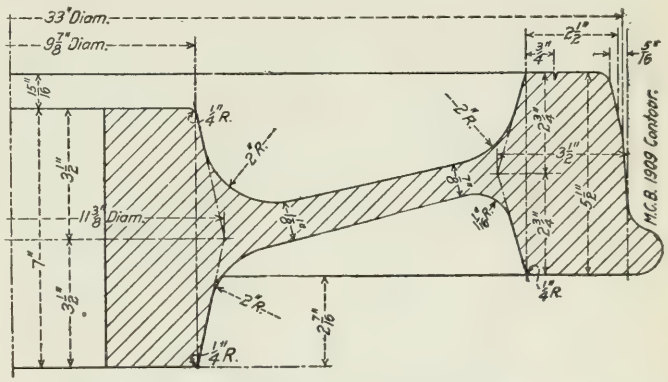


Fig. 2.—Steel Wheel for Tenders, Freight and Passenger Cars.

wheels of which the total number required is not sufficiently large to enable manufacturers, even under the best of conditions, to reduce the cost of production to the same level as that of the other classes of which larger quantities are used—that specific attention and study should be given to this dimension of inside hub face diameter, so that a standard can be adopted for the best interests of all concerned.

For a 6 in. x 11 in. axle the hub diameter is increased from 9⅞ in. to 11 in., to provide proper hub wall thickness and this brings up a point which I wish to make one of the principal features of my paper, i.e., what is the proper hub wall thickness for solid steel wheels?

A hub diameter of 9⅞ in. has long been recognized as all that is required in mounting solid steel wheels on 4¼ in. x 8 in., or 5 in. x 9 in., or 5½ in. x 10 in. axles, i.e., up to and including 7 in. diameter wheel-seats, for even in connection with the 5½ in. x 10 in. axle, and allowing for the eccentricity provided for in the specifications, a 9⅞ in. hub diameter means a minimum hub wall thickness of 1¼ in. on a 7 in. diameter wheel-seat. During the past few months, and under the leadership of one of our large systems, which, however, is basing its statements and acts on experience with comparatively few solid steel wheels, there

* Abstract of a paper read at the meeting of the Western Railway Club.

as been quite a move on the part of some roads, none of hose which have had long and extensive experience in the natter, however, to use wheels with 11 in. hub diameter on ¾ in. x 10 in. axles, and even on 5 in. x 9 in. axles, on the roud that 1¼ in. is not sufficient for a minimum hub wall hickness and tended to "loose wheels." From a manufacurer's standpoint I have no reason to take exception to his move. A heavier wheel means a higher price, and so ong as a railway wishes to pay for excess metal I do not now that it is within a manufacturer's province to object But as one of the engineers who has had to do with the olid steel wheel subject from its infancy, and who is more r less responsible for the dimensions, I wish to assume ust as definite and positive an attitude on this point as ords will permit me to express.

I have long been in touch with this particular point and ave had considerable personal experience in the boring and nounting of wheels, and since this question was raised ecently I have made a further study of it and consulted ith representatives of those roads which are qualified by ong and extensive experience to speak definitely and inelligently on the subject. I find that one large system, aving over 200,000 solid steel wheels in service, has had ess than a dozen loose wheels in the past six or seven ears, despite the fact that 1¼ in. minimum hub wall thickess has been the adopted practice, and that in the early ays of the solid steel wheel industry, when manufacture was ot as accurate in some ways as at present, many wheels ent into service with 1⅜ in. hub wall thickness. Of still reater interest, perhaps, is the fact that close investigation f each one of these few cases of loose wheels developed the act that the trouble was due, solely and entirely, to improper boring and mounting and had no reference whatsoever to the wall thickess of the hub of the wheel. From nother large system, with upwards of 90,000 solid steel heels in service, I learn that in six or seven years only hree or four cases of loose wheels have developed, despite he hub wall thickness of 1¼ in. minimum; investigation of hese few cases showed them to be due to improper boring nd mounting.

Such being the experience of those whose long and exensive use of solid steel wheels certainly qualifies them to now whereof they speak, I look upon it as a piece of undue ssumption when a road with a limited experience, both in ime and in quantity, sets out to be aggressive along a line ith which it is unfamiliar. A hub wall thickness of 1¼ n. is all that is required with properly designed and manufactured solid steel wheels mounted on axles with wheelseats up to and including 7 in. diameter; those who are roubled by loose wheels under such conditions must look o their own shop practice, to their boring-mills, their axlelathes, and their wheel-presses.

Some roads in wishing for something larger than a 5½ n. x 10 in. axle have, for reasons of their own, doubtless, neglected to adopt the M. C. B. standard, 6 in. x 11 in., and have gone to the use of sort of an "in-between," 6 in. x 10 n., which renders it necessary to add these two extra designs of wheels. As I am discussing wheels I do not like o encroach on another subject, but it seems to me that as much axle trouble is caused by over-heating as by lack of section, and that conditions are not much improved by increasing the section without proportionate increase in bearing. In other words, is there any great advantage in a 6 in. x 10 in. axle over a 5½ in. x 10 in., the adoption of the 6 in. x 11 in. axle, instead of a mere "in-between"? I refer to this as merely another one of those features which has its effect on the cost of manufacture, and therefore the price to the railways of solid steel wheels.

Another point is brought up by the suggestion that, though shown as standard designs, I would like to eliminate the 30½ in. engine truck wheel, 33½ in. engine truck wheel, and two of the wheels used for cars, solely because they mean the use of solid steel wheels with a 3 in. rim thickness. Experience tends to prove that a 2½ in. rim thickness in connection with solid steel wheels makes for efficiency and economy, and that the use of 3 in. thickness is to be avoided. In the first place, one must consider the rim of a solid steel wheel as being of two general parts, the allowable wearing-body, being that depth which can be properly used in service, and the minimum allowable rim thickness, which necessitates removal from service. For example, in a rim thickness of 2½ in., it may be said that there is 1½ in. of allowable wearing-body, with 1 in. thickness remaining which calls for removal from service under M. C. B. Rules. It must be borne in mind that this 1½ in. of allowable wearing-body cannot be entirely used in road service. From time to time while the wheel is in service certain deformations of contour will occur, after varying mileages and with correspondingly varying depths of metal worn from tread, which necessitate removal of the wheel from service for re-machining to restore the contour.

Long experience, with general averages on numerous roads and under varying conditions, indicates that the allowable wearing-body in a rim 2½ in. thick will split-up far more economically than the wearing-body in a 3-in. rim, or, to put it in another way, as a general average proposition a road will secure more actual sixteenths of an inch of wearing-body, and fewer sixteenths of an inch of waste metal in the allowable wearing-body of a 2½ in. rim than in a 3 in. rim. And though this broad statement of fact may seem to over-shoot the mark, and to evoke remonstrance from those who have not given the point specific attention, all I ask is the opportunity for co-operative study with any railway official of conditions on his road, and I will be able to clearly demonstrate the correctness of my statement. To properly meet the conditions a solid steel wheel should possess, throughout the depth of its allowable wearing-body, an attrition-resistance equal to that of the rail, and, to obtain this, certain limits must be recognized in rim thickness from a manufacturing standpoint. Not alone must a high degree of attrition-resistance be obtained initially, but it should be maintained, as uniformly as possible, throughout the allowable wearing-body: this quality is largely secured by the work, and the depth of penetration of the work, which is put upon the rim. There is no process of manufacture of solid steel wheels known to-day which will produce as good and serviceable a wheel with a 3 in. rim thickness as with a 2½ in. rim thickness. Based on the records of a good many thousand wheels which have been worn out in service, the mileage-life of a solid steel wheel with 2½ in. rim thickness is greater than one with 3 in. rim thickness, all other things being equal.

I have always been, and I am to-day, a strong and persistent opponent of the use of the term "shelling" in connection with solid steel wheels. There has been too much of a tendency to call all defects shelling, owing to either convenience or lack of familiarity with the subject, whereas proper analysis would have classed the defect under one of three or four other and more specific headings, which would have enabled the manufacturer to handle the matter far more intelligently and in a manner decidedly more for the benefit of the railway. Shellig may be the easiest thing to think of, or to say, but it is absolutely non-specific under normal conditions in connection with solid steel wheels, and in 99 cases in a 100 means nothing at all. The chilled por-

tion in the rim of a cast iron wheel extends at right-angles to the chill-block, and only to a certain depth, this depth being dependent on the quality of the iron, etc. The effect is a slight depth of metal with strong resistance, backed with ordinary gray iron of far less resistance, bordering, comparatively speaking, upon sponginess. When this strong surface metal had been worn so thin as to be unable to support the service-load which was on it, it would, having but a comparative sponginess or cushion beneath, mash-up and fall away in a manner which left the appearance of the outside of an oyster shell, and hence the term "shelling."

I have always opposed the use of the term "shelling" as applied to solid steel wheels, for I have believed, and my belief has been based on specific study, that no such condition should exist in properly designed and made solid steel wheels. But I must now go on record as saying that if some railway officials persist in using wheels with a 3 in. rim thickness, or over, and can succeed in inducing manufacturers to supply such types, then I must, though most regretfully, add the item of shelling to the liabilities of solid steel wheels, for close observation of many wheels of this type, not confined to any one manufacturer's product, convinces me that in a properly made solid steel wheel with a 2½ in. rim thickness there is good opportunity for knowing what you are getting, whereas with a 3 in. rim thickness you cannot be sure of anything, except that there will be a considerable percentage of dissatisfaction and trouble in the results. Let those who doubt the correctness of my position in this matter take note of the fact that the roads which have had the longest and most extensive experience with solid steel wheels have nearly all given up the use of wheels with a 3 in. rim thickness and have adopted the 2½ in. thickness as standard.

For years I have been an advocate of the idea of producing wheels so true to dimensions that the machine work was reduced to a minimum. I am still a firm believer in the theory, but only to the extent to which it can be carried in justice to the quality of the material produced. Machine work increases the cost of production, and it may often remove metal of particular service value, yet if the effort to produce material on which machine work is unnecessary opens the door to a product which lacks uniformity, lacks many of the other virtues which it should possess, and borders on the dangerous, then extreme caution should be used in order that a "penny wise, pound foolish" policy be avoided. It may be all right to produce some of the commodities of life on the basis of tonnage, or general average, but in dealing with wheels let us not forget that we are dealing with units, each and every one of which should possess integrity; otherwise, much time will be spent in settling claims for low mileage, in providing for adjustments covering defective material, and, worse yet, in explaining how wrecks occurred. Uniformity in manufacture is perhaps the feature most to be desired in connection with solid steel wheels. But uniformity of quality should be held as paramount to uniformity of mere dimensions.

The production of proper solid steel wheels does not entail the mere forming of a bulk of steel into the shape of a wheel. It carries with it far greater requirements and responsibilities. Proper production means not alone mere shaping, but, and particularly, the working into shape along such lines as tend to preserve and develop the virtues of the material for the service in which the finished product is to be used, and the doing of this in such a way as to assure uniformity and quality as between wheels which are subsequently mated in service. Irregularity of dimensions can be easily overcome by a few pennies' worth of machine work, but lack of uniformity in quality is incurable and is sure to assume more or less serious, if not actually dangerous, forms when the wheels go into service.

Manufacturers of solid steel wheels are particularly accommodating when engaged in close competition for an order, and it is for that reason that wheels of all sorts and sizes can be obtained. But clear-headed railway officials certainly realize that the production of small quantities of an endless variety of designs means a higher cost than when a minimum number of designs permits of proportionately larger quantities, and that cost is always reflected in price. They certainly realize that in the heat of close competition a sales department will frequently offer odd designs which may or may not have been thoroughly demonstrated as unifying the possibilities of proper manufacture and the requirements of service, and they surely appreciate how standardization of wheel designs is an end to which we all should strive.

ELECTRO-METALLURGY OF TIN.

In speaking of recent experiments upon the electro-metallurgy of tin, le Journal du Four Electrique (January, 1912), reaches the conclusion that the solution of the problem has been found as regards general lines of work, and that it remains only to study the minor questions of detail. The statement is made that the yield of tin ores is much increased by electric-furnace treatment, that the process is continuous as against intermittent smelting in the reverberatory, that the formation of "hardhead" is reduced greatly, and that the quantity of carbon necessary for reduction is no more than 14 per cent. in the electric furnace, as against 20 to 25 per cent. in the reverberatory. The floor space necessary for the installation is smaller, and the consumption of the electrodes is negligible.

Some calculations are given as to the energy required for the reduction of cassiterite; the basis of these calculations is as follows: For the reduction of 118 grams of tin from stannic oxide, 145,300 gram cal. are required. The reaction, $C+O_2=Co_2$, gives out 96,960 cal., and the reaction, $2C+O_2=2CO$, 58,000 cal. It is necessary. then, in order to set free 118 grams of tin that we should have, for the first reaction, 145,300—96,960 cal., or 409,661 kg.-cal. per kilogram of tin set free, and since 1 kw.-hr. equals 864 kg.-cal.. it is necessary per ton of tin to have 474 kw.-hr. of energy. This figure becomes 855 kw.-hr. if we apply the equations $2C+O_2=CO$. As in practice, each of these reactions gives about 50 per cent. of the reduction, it is necessary to count on the average as the consumption of energy required, which is 665 kw.-hr. per ton of tin. The temperature in the smelting zone is estimated at 1,400 or 1,500° C., and the calorific balance of the furnace is then as follows: For the reaction, 665 kw.-hr.; for heating the slag, 130; for the specific heat, 45; losses by radiation, 130; losses through hot gases, 130 kw.-hr.; a total of 1,140 kw.-hr. per ton of tin.

The experiments were made in the furnace like that of Harmet for the reduction of iron ores, constructed of magnesite brick. A product was obtained containing about 99 per cent. tin, little iron, and free from arsenic. At the beginning of the campaign, which usually lasted from 10 to 12 days, the furnace was heated for a day with wood and coke in order to dry the bricks and then charged with about 14 kg. of anthracite coal per 100 kg. of ore, this proportion, however, depending on the nature of the latter. A current was then passed of about 1,000 amp. at 60 v., these figures changing to 40 v. and 2,500 amp. when the reaction commenced. A half-hour afterward the slag commences to

form and its aspect alone suffices to show whether the charge is of the proper composition or not. Experiments have also been made to recover the tin from the furnace slags by an electrolytic method. These were fused with soda and the mass afterward dissolved in water and electrolyzed with plates of iron as a cathode. Excellent deposits of tin were obtained, but the yield was not high.

ONTARIO HYDRO-ELECTRIC LEGISLATION.

The following powers are conferred on the Hydro-Electric Commission by a bill introduced in the Ontario House to amend the Power Commission Act:—

To take over existing power transmission lines and to improve water powers, by assisting municipalities and others in the storage of water, making of sluices, etc.;

To expropriate a local distributing plant where a municapility has voted to enter into a contract with the commission for a supply of power;

To regulate installation of electrical equipment and installation of wires in all buildings including private houses;

To require the appointment by municipalities of inspectors to see that such regulations are carried out;

To order the removal and alteration of any works that are a menace to the public safety or endanger life;

To control absolutely light and power rates charged by municipalities whether those municipalities take power from the Commission or not;

To control the rates of any company or individual taking power from the Commission;

To prescribe a uniform system of bookkeeping on the part of power municipalities;

To direct the disposal of surpluses earned by municipal power plants supplied by the Commission. (In many cases these surpluses are now devoted to the building of sidewalks, street sweeping, etc.);

To order all wires under its jurisdiction underground in cities and towns;

With the co-operation of the Dominion Railway Commission to order underground all wires strung on streets where the municipalities construct tunnels or conduits to carry such wires;

To impose a penalty of $100 per day for any disobedience of any such order.

CEMENT PRODUCTION LAST YEAR.

Complete statistics have been received from the manufacturers of cement covering their production and shipments during the year 1911. These returns show that the total quantity of cement made during the year, including both Portland and slag cement was 5,677,539 barrels as compared with 4,396,282 barrels in 1910, an increase of 1,281,257 barrels, or 29 per cent.

The total quantity of Canadian Portland cement sold during the year was 5,635,950 barrels as compared with 4,753,975 barrels in 1910, an increase of 881,975 barrels, or 18.5 per cent.

The total consumption of Portland cement in 1911 including Canadian and imported cement and neglecting an export of Canadian cement, valued at $4,067 was 6,297,866 barrels as compared with 5,103,285 barrels in 1910, or an increase of 1,194,581 barrels, or 23.4 per cent.

Detailed statistics of production during the past three years are shown as follows:—

	1909. Barrels.	1910. Barrels.	1911. Barrels.
Portland cement sold	4,067,709	4,753,975	5,635,950
" manufactured	4,146,708	4,396,282	5,677,539
Stock on hand Jan. 1.....	1,098,239	1,189,731	844,741
" Dec 31 ...	1,177,238	832,038	903,590
Value of cement sold	$5,345,802	$6,412,215	$7,571,299
Wages paid	1,266,128	1,409,715	2,103,838
Men employed	2,498	2,220	3,010

The average price per barrel at the works in both 1910 and 1911 was $1.34, as compared with an average price of $1.31 in 1909 and $1.39 in 1908.

The imports of Portland cement during the twelve months ending December 31, 1911, were 2,316,707 cwt., valued at $834,879. This is equivalent to 661,916 barrels of 350 pounds at an average price per barrel of $1.26. The imports in 1910 were 349,310 barrels, valued at $468,046 or an average price per barrel of $1.34.

The imports from Great Britain during 1910 were 190,506 barrels, valued at $210,839; from the United States 441,317 barrels, valued at $575,768; from Belgium 2,683 barrels, valued at $2,019; from Hong Kong 22,059 barrels, valued at $38,292; and from other countries 5,351 barrels, valued at $7,962.

Following is an estimate of the Canadian consumption of Portland cement for the past five years:—

Calendar Years.	Canadian. Barrels.	Per cent.	Imported. Barrels.	Per cent.	Total. Barrels.
1907	2,436,093	78	672,630	22	3,108,723
1908	2,665,289	85	469,049	15	3,134,338
1909	4,067,709	97	142,194	3	4,209,903
1910	4,753,975	93	349,310	7	5,103,285
1911	5,635,950	89.5	661,916	10.5	6,297,866

TABLE SHOWING THE ANNUAL VALUE OF THE MINERAL PRODUCTION OF THE PROVINCE OF QUEBEC SINCE 1900.

(Compiled by Mines Branch, Province of Quebec.)

Year.	Value.
1900	$2,546,076
1901	2,997,731
1902	2,985,463
1903	2,772,762
1904	3,023,568
1905	3,750,300
1906	5,019,932
1907	5,391,368
1908	5,458,998
1909	5,552,062
1910	7,323,281
1911	8,567,143

In our issue of the 7th inst., through a mechanical error, we regret that the illustration of the new Watts Stadia hand level and of the Improved Abney level appeared upside down. We feel certain that our readers recognize that this was a typographical error and hope that they were not puzzled by what seemed to be an apparently peculiar construction of the instruments made by this well-known, reliable firm.

In addition to the instruments above mentioned, E. R. Watts & Son are offering at very reasonable prices a new pattern surveying compass and also a C.E. dumpy level having several special features.

HAMILTON'S HARBOR.

The development of Hamilton harbor is probable. A delegation from the city waited on the Prime Minister and the Minister of Works, at Ottawa, requesting various improvements. The importance to the shipping business at Hamilton was emphasized by Mayor Lees, and the certainty that this business would increase in the near future. He stated that Hamilton's shipping business was now second only to that of Montreal among the inland ports of Canada. To the present, improvements to the harbor had largely been made by the city or by private firms which had to carry out work to provide themselves with shipping facilities. The Federal Government had given some aid and the time had come when there should be more. Hamilton was a great manufacturing centre, and destined to become greater. What was now required was a two thousand foot extension of the revetment wall, widening of the entrance to the harbor and dredging along the south shore of the harbor. It is estimated that the improvements asked for will involve an expenditure of $400,000.

ENGINEERING NOTES.

In the course of an address given before the Engineering Society of the North Western University recently, Mr. H. G. Tyrell stated that most of the bridges in the United States are considered merely as objects of utility. Europe is much farther advanced on this score, for its bridge builders see in a bridge something that can be made to harmonize with beautiful surroundings or to beautify ugly ones. That such artistic forethought will add immeasurably to the beauty of the country is evident from the fact that we have now 80,000 iron bridges, not to mention thousands of wooden ones of every description.

Montreal, Que.—Principal Peterson, of McGill University, is reported to have stated at the closing exercises of the Technical School, that Canada is thirty years behind the world in technical education. He added that the governments at Quebec and Ottawa would have to come to the assistance of the people of Canada if they are to regain their place in technical and commercial education.

Province of Manitoba.—The financial statement of the province shows a balance of $492,426 as a surplus. The estimates for the present year call for an expenditure of $5,056,245, and of this amount $2,207,000 is for public buildings.

Ottawa, Ont.—Chief Engineer Armstrong, of the Hudson Bay Railroad, with headquarters in Winnipeg, has been notified by Hon. Frank Cochrane, Minister of Railways, to send out at once a party of engineers to the Hudson Bay, one party to go to Port Nelson and one to Fort Churchill. They will remain at the ports for a couple of months taking observations and making surveys as to the suitability of the ports for terminals.

The German government are considering the state ownership of petroleum, spirits, potash and matches.

Galt, Ont.—The municipal authorities of this progressive little town have turned their attention in a very serious manner to the question of municipal milk supply. An inspector was appointed and visited the source of the supply in many instances. In such cases as conditions were found to be below standard he displayed the progressive spirit that has been evident on other occasions, and distributed instructive literature to the owners of cattle dealing with the proper care of cows and dairy matters. The result showed that the effort produced better milk and less hard feeling than the older method of dealing with the offenders through the police court.

Fort William, Ont.—Mr. Farquharson, manager of the municipal electric light plant of this city, recently gave out some interesting facts regarding the meter and flat rate system of current sales. He stated that in Fort William there are now in use 1,648 meters. The meter is the strongest factor for holding down of the peak load, which without meters would have been close to 2,500 h.p. during 1911, and with no extra revenue. While we have flat rates on light that entitles the consumers to attach any load, either cooking utensil or heater, there will always be a large percentage of peak load consumed on prodigal use of light and stolen power, other than what is paid for. That there are a great many electric heaters in use by flat rate was noticed during the peak period, and whenever a cold spell would stop, aproximately 75 h.p. would drop off from the peak load. The people now do not object to meters as formerly, as they are beginning to understand that the meter is the only intelligent and economical way to purchase current.

The municipal electric light department of Fort William, Ont., earned a net surplus of $17,255.92 during the year 1911. The total working expense of distribution and operation per horse power purchased has been, interest and sinking fund included, $51.23, as against $50.70 in 1910, and $47.04 in 1909. Against this the earnings per horse-power in 1911 were $61.93, in 1910 $59.18 and $51.35 in 1909.

Montreal, P.Q.—The Ives foundry was the scene of a trial of the Uno-Rail system of car operation recently. The truck of this car is built so that the main load rests on the top rail, which is V shaped, and has two side rails of the same shape, for the purpose of preventing any derailment. One of the main features is the little space that it takes up, requiring a right of way of only eight feet. The facilities of climbing heavy hills are by means of the Roch rail and gear, which allows the truck to follow the contours of the ground very closely. The line can be built so as to cross, over or under railways, and across rivers and canals.

Work on the new high level bridge is well under way in Ottawa, Ont. The present swing bridge has been moved from the old stone pier sixty feet and has been placed upon a wooden pier, the stone piers being removed by blasting. To support the pier on the Driveway side of the bridge an immense concrete retaining wall will be built and upon this a great number of men are now working. The space between the bank and the wall will be filled in with earth and stone which has been taken from the bottom of the canal. This wall will be 200 feet long and will be finished before the water enters the canal in May.

The British Admiralty has now had complete plans drawn up for a specially built navy hospital ship, which is to be ready in June, 1913. The estimated cost is $500,000.

PERSONAL.

Mr. H. C. Tyrrell gave a lecture before the Engineering Society of the North Western University on March 12th last.

Mr. Angus Smith, city engineer of the city of Victoria, B.C., has tendered his resignation to the Board of Control.

Mr. Myer J. Sturn is making an inspection of the schools in the city of Regina regarding the matter of ventilation.

Mr. Francis P. Smith, M. Am. Soc. C.E., chemical and consulting paving engineer, New York City, on March 8th delivered an illustrated lecture on "Mixing Plants for Bituminous Pavements" before the graduate students in highway engineering at Columbia University.

OBITUARY.

A well-known civil engineer in the person of **Charles Thompson Harvey** has passed away. Mr. Harvey died in New York on March 13th last. He became prominent partly through the active part taken in the Sault Ste. Marie ship canal, and the first elevated railway to be constructed in New York. He was 83 years of age.

PERMANENT MANUFACTURERS' EXHIBIT OF RAILWAY SUPPLIES AND EQUIPMENT.

From March 16th to 23rd, inclusive, there is being held in the Karpen Building 900 South Michigan Boulevard, Chicago, Ill., an exhibit of railway supplies and appurtenances of interest to persons dealing in these materials. The exhibit occupies the entire twelfth floor of this building. The exhibition hall contains twenty thousand square feet of floor space. Arrangements have been made for the supply of steam, electricity and compressed air for the operation of working models. Every effort has been made to have the exhibit as complete and diversified as possible.

MEETINGS.

The Dominion Land Surveyors' Association held their annual banquet in Ottawa recently. The chair was occupied by the president, Mr. Thomas Fawcett. Among the guests were Senator C. P. B. Casgrain, D.L.S.; Mr. P. B. Symes, Dr. E. Deville, Dr. W. F. King, Dr. O. J. Klotz, and Mr. C. A. Magrath.

COMING MEETINGS.

CANADIAN INSTITUTE.—198 College Street, Toronto. Saturday Evening Lectures, 8 p.m. March 23rd, "Waste Land Problems," by Dean Fernow, Toronto University. March 30th, "Spectral Lines—their Arrangement and Constitution," by Prof. J. C. McLennan, Toronto University. April 13th,—"Lantern Experiments on Reaction in Non-homogeneous Systems," by Prof. Kenrick, Toronto University.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary-Treasurer, R. W. Macintyre

QUEBEC BRANCH—Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—Secretary E. Brydone Jack. Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—Chairman, Geo. H. Webster: Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. V. Ross.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
3-18	Concrete reservoir (2,000,000 gallons' capacity), Moose Jaw, Sask.....(P. & S.)	2-22
3-18	Centrifugal pumps, motors, etc., Moose Jaw, Sask. .....(P. & S.)	2-22
3-18	Valves and Fittings, Moose Jaw, Sask. .....(P. & S.)	2-22
3-18	96,000 ft. of 18-in. Steel Pipe, Moose Jaw, Sask. .....(S.)	2-22
3-15	Pavements, Welland, Ont. .....(P. & S.)	2-29
3-25	Prime mover equipment, electric lighting equipment, etc., Moose Jaw, Sask.....(S.)	3-7
4-8	Paving, Port Arthur, Ont. .....(S.)	3-21
4-11	Grading, sanitary sewers, cement walks, etc., Lethbridge, Alta.....(P. & S.)	3-14

(Lethbridge plans and specifications are on file at The Canadian Engineer Office, 820 Union Bank Building, Winnipeg.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Calgary, Alta., designs for aqueduct	May 1.	Feb. 22.	70
Calgary, Alta., electric machinery	Mar. 20.	Feb. 8.	68
Calgary, Alta., steel highway bridges	Apr. 15.	Mar. 14.	68
Carp, Ont., church	Mar. 21.	Feb. 7.	59
Cheticamp, N.S., dredging	Mar. 20.	Feb. 7.	60
Fredericton, N.B., concrete substructure and approaches to bridges	Apr. 1.	Feb. 29.	59
Fredericton, N.B., culvert, McKenzie Hollow	Apr. 3.	Feb. 7.	89
Fredericton, N.B., culvert, Pokiok Embankment	Mar. 25.	Feb. 7.	59
Halifax, N.S., garbage incinerator	Mar. 27.	Mar. 14.	59
Hamilton, Ont., canning factories, etc.	Mar. 23.	Mar. 14.	59
Lethbridge, Alta., grading, sanitary sewers, etc.	Apr. 11.	Mar. 14.	70
Lorneville, N.B., extension to breakwater	Apr. 1.	Feb. 7.	60
Merid, Sask., road grader and scrapers	Mar. 24.	Feb. 7.	60
Moose Jaw, Sask., turbo-generating set; generator	Mar. 30.	Feb. 7.	60
Moose Jaw, Sask., prime mover equipments, etc.	Mar. 29.	Feb. 7.	68
Oakville, Ont., sewage disposal works	Apr. 1.	Mar. 14.	68
Point Grey, B.C., plans for			
Port Arthur, Ont., paving	Apr. 8.	Mar. 14.	68
University	July 31.	Feb. 7.	60
Prince Albert, Sask., sewer and waterworks	Mar. 29.	Mar. 14.	72
Saskatoon, Sask., pavement	Apr. 5.	Mar. 14.	68
Saskatoon, Sask., electrical equipment	Mar. 22.	Feb. 29.	68
Saskatoon, Sask., labor on storm sewers	Mar. 29.	Feb. 29.	72
Saskatoon, Sask., sewer and water construction	Mar. 29.	Feb. 29.	72
St. Jerome, Que., hydro-electric installation		Feb. 7.	68
Toronto, Ont., electrical equipment	Mar. 26.	Feb. 7.	68
Toronto, Ont., work on T. & N.O. Rly.	Mar. 20.	Feb. 7.	60
Toronto, Ont., Registry and Land Titles Office additions, North Bay, Ont.	Mar. 26.	Mar. 14.	60
Toronto, Ont., water meters	Mar. 26.	Mar. 14.	72
Toronto, Ont., Garrison Creek extension	Mar. 26.	Mar. 14.	68
Toronto, Ont., high level interceptor	Mar. 26.	Mar. 14.	70
Vancouver, B.C., water pipe	Mar. 20.	Feb. 29.	60
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., cables	Mar. 25.	Feb. 15.	60
Winnipeg, Man., asphalt	Mar. 20.	Mar. 14.	68
Winnipeg, Man., well turbine pumps	Apr. 1.	Mar. 14.	60

TENDERS.

Brampton, Ont.—Tenders will be received up to 6 p.m. March 26th, 1912, for the construction and supply of the following:—

(a) Concrete reservoir.
(b) Two turbine pumps and motors.

Plans, etc., can be obtained at the Municipal Office of the Town, and from the Engineer. J. G. Roberts, Chairman, Brampton Waterworks Commission. Wm. Treadgold, Engineer.

Edmonton, Alta.—Tenders will be received up to noon of April 1st, 1912, for the tile and marble work in connection with the Parliament Buildings, Edmonton. Plan, etc., at the Structural Engineer's office, new Parliament Bldgs., Edmonton, or at the branch office of the Dept. of Public Works, Calgary. John Stocks, Deputy Minister of Public Works, Edmonton.

Edmonton, Alta.—Tenders will be received until April 1, 1912, for the supply of approximately 300,000 bricks for the Court House, Calgary. Specifications, etc., at the office of the Structural Engineer, New Parliament Buildings, Edmonton, and at the branch office of the Dept. of Public Works, Calgary. John Stocks, Dep. Minister of Public Works, Edmonton.

Hollywood, Man.—Tenders will be received until March 27th, 1912, for the erection of a solid brick school with full sized cement basement, in the village of Langruth, Man. Plans and specifications may be seen at the Municipal Office, Portage la Prairie, or at Langruth, Man. Address, G. G. Moorehead, Sec.-Treas., Hollywood, Man.

Moose Jaw, Sask.—Tenders will be received by the City Commissioners until March 29th, 1912, for the installation of approximately three miles of 8 and 10-inch sewer mains and 6-inch water mains. Plans, etc., at the office of J. Antonisen, City Engineer, Moose Jaw.

Moose Jaw, Sask.—Tenders will be received by the City Commissioners up to noon of March 25th, 1912, for the supply and delivery of 500 feet 2½-inch, 3-ply cotton, rubber-lined fire hose.

Moose Jaw, Sask.—Tenders will be received by the City Commissioners, Moose Jaw, until April 13th, 1912, for one year's supply (approximately 7,000 tons) of steam coal. Particulars with J. D. Peters, Electrical Supt.

Manotick, Ont.—The commissioners of Manotick Police Village are prepared to receive tenders for the construction of about 10,000 square feet of concrete walk. Tenders will be open until 23rd of March. Particulars will be furnished by the secretary, R. Gamble.

Niagara Falls, Ont.—Tenders will be received until April 1st, 1912, for the construction of approximately 75,000 sq. yards of pavement, in wire-cut paving block, vitrified brick, westrumite, bitulithic, asphalt block or concrete. Specifications at the office of the City Engineer, Niagara Falls, Ont. W. J. Seymour, City Clerk. (See advertisement in Canadian Engineer).

North Toronto, Ont.—Tenders will be received until March 25th, 1912, for concrete sidewalks and bridges. Wm. C. Norman, Clerk, North Toronto, Ont. (See advertisement in Canadian Engineer).

North Bay, Ont.—Tenders will be received until March 25th, 1912, for the erection and completion of an eight-room Public school, including heating and plumbing. Plans, etc., at the office of the architect, H. W. Angus, McCool Block, North Bay. Tenders to be received by E. H. Young, Secretary Public School Board, North Bay.

Ottawa, Ont.—Tenders will be received until April 15th, 1912, for the construction of an extension to the north breakwater and dredging, at Goderich, Huron County, Ont. Plans, specifications, etc., can be obtained at the offices of J. G. Sing, Esq., District Engineer, Confederation Life Building, Toronto; H. J. Lamb, Esq., District Engineer, Windsor, Ont.; Postmaster at Goderich, Ont., and at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received up to noon of April 1st, 1912, for the charter to this department of one or two steamers for Fishery Protection Service on the Pacific Coast. Vessels should meet following requirements: Length between 140 feet and 200 feet; gross tonnage between 300 tons and 400 tons; maximum speed not less than 10 knots. Copies of the conditions of the charter may be obtained on application to the Naval Store Officers, H.M.C. Dockyard, Esquimalt, B.C. G. J. Desbarats, Dep. Min. of the Naval Service, Dept of Naval Service, Ottawa.

Ottawa, Ont.—Tenders will be received until April 15th, 1912, for the construction of an extension to the north breakwater and dredging, at Goderich, Huron County, Ont. Plans, specifications, etc., can be obtained at the offices of J. G. Sing, Esq., District Engineer, Confederation Life Building, Toronto; H. J. Lamb, Esq., District Engineer, Windsor, Ont.; Postmaster at Goderich, Ont., and at the office of R. C. Desrochers, Secretary Department of Public Works, Ottawa. (See advt. in Can. Eng.)

Ottawa, Ont.—Tenders will be received until the 20th of April, 1912, for the construction of a wooden lighthouse and dwelling combined on a concrete pier and protection work on Holland Island, Chatham Sound, B.C., and also for the construction of a reinforced concrete tower, double dwelling and a fog alarm building, at Point Atkinson, in the province of British Columbia. Plans, etc., at the office of the agency of the Department, Victoria, B.C.; Post Offices, Vancouver and Prince Rupert, B.C., and office of A. Johnston, Deputy Minister of Marine and Fisheries, Dept. of Marine and Fisheries, Ottawa.

Ottawa, Ont.—Tenders, bulk and separate, addressed to chairman of the Board of Control, will be received until March 26th, 1912, for the several works required in the erection and completion of a machinery hall in Lansdowne Park. Plans and specifications at the office of Architect Noffoke, 37 Central Chambers, Ottawa. John Henderson, City Clerk, City Hall, Ottawa.

Ottawa, Ont.—Tenders will be received by the Dept. of Public Works, Ottawa, until April 9th, 1912, for additions and alterations to the Fuel Testing Building, Ottawa. Plans, etc., can be obtained at this Department.

Prince Albert, Sask.—Plans for a large three-story police station, prepared by A. G. Creighton, architect, have been passed by the city council, and tenders are being called for the erection of the structure, by the police commission.

Prince Rupert, B.C.—Tenders for the supply of approximately 3,800 ft. of steel pipe, 18 inches in diameter, delivered on the wharf, Prince Rupert, will be received until March 25th, 1912. Full particulars may be obtained from Wm. Mahlon Davis, City Engineer. Ernest A. Woods, City Clerk.

Red Deer, Alta.—Tenders for all work except excavating and concrete walls and steel work to ground floor level and plumbing and heating for the Alberta Ladies' College, Red Deer, will be received until April 1st, 1912. Plans and specifications at the offices of C. A. Julian Sharman, architect, Red Deer; Barnes and Gibbs, architects, Edmonton; the Builders' Exchange, Calgary, and the Builders' Exchange, Winnipeg. J. Malcolm, Esq., Chairman Building Committee, Alberta Ladies' College, Red Deer.

Sudbury, Ont.—Tenders will be received until April 17th, 1912, for the following works:—

Contract "A"—Main Sewer, 8,555 ft. 20-in., 18-in., and 15-in.
" "B"—Sanitary Sewers and Force Mains.
" "S"—Sewer Pipes and Junctions.

Plans and specifications at the office of the Town Clerk, Sudbury, or at office of the Engineers, Mail Building, Toronto. Chipman & Power, Engineers.

St. Thomas, Ont.—Tenders will be received until noon on Friday, March 29th, for Port Stanley waterworks. For full particulars address Messrs. Jas. A. Bell & Sons, engineers, St. Thomas, Ont. (See advt. in Canadian Engineer).

Sydney Mines, C.B.—Tenders will be received until March 30th, 1912, inclusive, for building an "Annex" to "Harbor-View Hospital," Sydney Mines. Plans, etc., at the general office of the N.S.S. & C. Co., and at the Town Engineer's office, Sydney Mines; also office of Herbert E. Gates, Esq., Architect, Halifax. Edmund McDonald, Secretary to Trustees, H. V. Hospital, Sydney Mines.

Toronto, Ont.—Tenders will be received until March 26th, 1912, for the excavating, laying and joining a 24-inch cast-iron water main on Sumach Street from Queen Street to Wellesley Street. Specifications, etc., at the office of the City Engineer, Toronto. G. R. Geary, (Mayor), Chairman, Board of Control, City Hall, Toronto.

Toronto, Ont.—Tenders will be received until March 26th, 1912, for the construction of the following sewers:—Benson avenue, Christie to 114 ft. 6 in. W. of Arlington; Rushton road, Benson to St. Clair; Ilford avenue, Arlington avenue to east end; Shaw street, Tyrell to St. Clair. Specifications and forms of tender at the office of the City Engineer. G. R. Geary (Mayor), Chairman Board of Control, City Hall, Toronto.

Toronto, Ont.—Tenders will be received until April 9th, 1912, for the construction of storm overflow sewer, Main Garrison Creek, Section 1. Specifications, etc., at the office of the City Engineer. G. R. Geary (Mayor), Chairman Board of Control, City Hall, Toronto. (See advt. in Can. Eng.)

Vancouver, B.C.—Tenders will be received until March 25th, for the supply and delivery of 1 twelve-ton road roller, either single cylinder or compound steam or gasoline. D. G. Tate, City Clerk, Vancouver, B.C.

Westmount, Que.—Tenders will be received until March 28th, 1912, for intercepting sewer, also paving, Western Avenue. Specifications, etc., at the office of the City Surveyor, Arch. Currie, Westmount, Que. (See advertisement in Canadian Engineer).

Welland, Ont.—Mr. Robt. Cooper, County Clerk of the above, will receive tenders for road machinery comprising:

2 steam rollers, 10 tons each.
2 rock crushers (portable).
2 bins for stone storage (portable).
2 revolving screens.
2 chain elevators.
2 road graders.
2 sprinkling wagons.
1 traction engine, 18 h.p.
2 pick plows.
2 wheel scrapers.

Tenders to be in by noon, April 2nd next.

Welland, Ont.—Tenders will be received up to noon of April 2nd, 1912, for the following stone for building roads under the County Good Roads System:—Crushed stone, per ton, and rubble stone, per cord, f.o.b. cars quarry, and delivered in car lots at different points of the county of Welland. (Signed) Robert Cooper, County Clerk, Welland, Ontario.

A CORRECTION.

In our advance news service sheet of March 18th last a request from Messrs. McDougal and Forster was made. The address of this firm is Edmonton, Alta.

Tarvia

Preserves Roads
Prevents Dust

Lancaster St., Berlin, Ont. Constructed with Tarvia X Modern Pavement

Meets Modern Road Requirements

TARVIA is a powerful binder for the surfaces and foundations of macadam roads. It fills the voids and locks the stone in a tough, durable, plastic matrix.

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CONTRACTS AWARDED.

Province of British Columbia.—Sub-contracts for the construction of the main line of the Grand Trunk Pacific eastward to Burns Lake near Fraser Lake, have just been awarded by Messrs. Foley, Welch & Stewart, general contractors, as follows:—Aldermere East, John Bostrom, eight miles; Freeburg & Stone, ten miles; Hugh McLeod, four miles; Sheady & Smith, seventeen miles; John Albi, ten miles. Bulkley Summit, westward, Duncan Ross, ten miles. Bulkley Summit, eastward, John McLeod, five miles; A. L. McHugh, ten miles; Dan Stewart, ten miles; D. A. Rankin & Company, fourteen miles along Burns Lake and eastward.

Guelph, Ont.—The directors of the Guelph Radial Railway have awarded the following contracts:—Steel rails, Drummond & McColl, Montreal; ties, Contractors' Supply Company, Toronto; wire, Dawson & Company, Montreal.

Kamloops, B.C.—Of the ten tenders received for the construction of a covered concrete reservoir, capacity 1,500,000 gallons, that of the Graff Construction Company, Vancouver, was accepted, their price being $32,729.89.

Lindsay, Ont.—A report from this town states that The Toronto Construction Company have been awarded the contract for the construction of the new Canadian Pacific Lake Front line, a distance of 178 miles.

Montreal, Que.—The contract for the covering of 2,200 ft. of Little St. Pierre River with concrete and sides shored by wooden planking, has been awarded to Messrs. Haney, Quinlan & Robertson, for $75,500.

Montreal, Que.—A theatre for the Canadian Amusement Company, Orpheum Bldg., will be built by Contractor C. E. Deakin, 11 St. Sacrament St. The steel work will be done by the Dominion Bridge Co., Lachine. Estimated cost, $100,000.

Ottawa, Ont.—Messrs. McDougals, Limited, have received the contract for the supply and delivery of valves required by the corporation of the city of Ottawa, for $4,659.36.

Ottawa, Ont.—The Montreal Bridge Company have been awarded the contract calling for the erection of the park stand at Connaught Park.

Ottawa, Ont.—The construction committee of the Connaught Park Jockey Club have awarded the contract for the steel work in connection with the grand stand at Connaught Park to the Dominion Bridge Company, of Montreal.

Prince Albert, Sask.—The National Iron Works Co. have received the contract of supplying cast-iron water pipe required by the city during the year 1912. Contract price, $43.40 per ton.

Saskatoon, Sask.—The successful bidders for the supply of waterworks materials for Saskatoon, ars as follows:—

For cast-iron pipe, the Canada Iron Corporation.	$72,200.00
For valves & hydrants, Messrs. Drummond, McColl	10,700.00
For corporation brass, the H. Mueller Mfg. Co. ..	3,000.00
For lead and iron pipe and service boxes, Messrs. Jas. Robertson Co.	8,500.00

Saskatoon, Sask.—The contract for the superstructure of the new Y.M.C.A. building has been awarded to the Frid-Lewis Co., Ltd., of Winnipeg, their tender being the lowest received, $69,300.

Saskatoon, Sask.—J. H. Simmons, of Winnipeg, has secured the contract for the construction of an express building and of outward and inward freight sheds.

Swift Current, Sask.—A six-stall engine house and express building will be constructed by J. McDiarmid Co., of Winnipeg.

St. John, N.B.—Mr. Hartman, of Montreal, P.Q., has been awarded the contract to erect a new sardine factory in this city. The plant is for the Canadian Sardine Co., Ltd., of which Mr. McColl is the manager at this point.

Truro, N.S.—The contract for the construction of a brick and stone civic building to cost $45,000 has been awarded to Messrs. Rhodes, Curry & Co., of Amherst, N.S.

Toronto, Ont.—The County of Hastings, Ontario, have awarded a contract for the supply of a concrete mixer to Messrs. Wettlaufer Bros., who will supply a No. 4 heart-shaped mixer.

Toronto, Ont.—The contract for the new Canadian Pacific Lake Shore road, which will branch from the present Toronto-Montreal line at Agincourt and rejoin it at Bathurst, west of Smith's Falls, a total distance of 198 miles, has been let to Messrs. Deeks & Hinds. The value of the contract is about $10,000,000. The construction work includes a number of tunnels, the longest being 850 feet.

Vancouver, B.C.—Contracts for the construction of additions to the Florence Nightingale and Cecil Rhodes schools were awarded to Robert McLean & Co. The tender on the former was $56,300 and the latter $53,000.

Vancouver, B.C.—The tender for hauling the Seymour Creek pipe has been awarded to Mr. F. C. Lane, at the price of $3.90 per ton.

Vancouver, B.C.—The Terminal City Iron Works were awarded the contract for the supply of hydrants for this city. Their prices were $41.50 for 200 ordinary hydrants, and $76.50 for hydrants with crane attachments. The Robertson Godson Company in competition tendered $40 and $68 for the same.

Vancouver, B.C.—The Terminal City Iron Works will supply 200 hydrants (without cranes) for Water Works Distribution System Extensions, at $42.50; and the Robertson-Godson Company, 40 hydrants (crane attachment) at $68.

Victoria, B.C.—The contract for the erection of the new high school has been awarded to Messrs. Dinsdale and Malcolm of this city, their price being $344,000. The various bids received were as follows: On the original specifications and as an alternative, Norton-Griffiths Steel Construction Co., $358,000-$337,000; Messrs. Dinsdale & Malcolm, $344,-000-$329,000; Thomas Catterall, $368,000-$348,073; Messrs. Bayne & Horie, $355,000-$337,800.

Victoria, B.C.—Messrs. Dinsdale & Malcolm have been awarded the contract for the new high school building, their tender of $344,000 being the lowest of four submitted.

RAILWAYS—STEAM AND ELECTRIC.

Collingwood, Ont.—A report states that a party of surveyors has completed a line of projected railway to this town. The plan shows a point named Baxter on or near the Toronto-Sudbury section of the C.P.R. as the start.

Coquitlam, B.C.—The Coquitlam Terminal Company are building a two-mile belt to serve factories and other buildings along the industrial sites of the Pitt River. It is to connect with the spur of the Canadian Pacific Railway on the north side of the main right-of-way.

Guelph, Ont.—At the annual meeting of the directors of the Guelph Radial Railway Company the following officers were elected:—J. W. Lyon, president; W. E. Buckingham, vice-president; C. E. Howitt, treasurer; J. U. Pequegnat, secretary. The company will do considerable construction work during the coming season.

Hull, P.Q.—The municipal council have advised that the Canadian Pacific Railway authorities be requested to build a station in proportion to the size and imporantce of the city.

Moose Jaw, Sask.—The plans of the entrance for the Grand Trunk Pacific Railway to this city, show that the railway will enter the city at Eighteenth Avenue, from which it will pass through Hillcrest in blocks 40, 39, 38, 37, 36 and 46. It then goes west through the Ross estate, crossing Main Street directly north of the exhibition grounds, goes west through several blocks in Lynbrook Heights, and passes out of the city through Victoria Heights.

Midland, Ont.—The Midland Terminal Railway has changed its name to the Midland-Simcoe Railway Company and has had its charter extended for three years.

Ottawa, Ont.—The name of the Ottawa, Smith's Falls and Kingston Railway has been changed to the Ottawa, Rideau Lake and Kingston Railway Company.

Port Colborne, Ont.—On March 27th the ratepayers will be asked to vote on a by-law fixing the assessment on all Grand Trunk property in that town at $16,000 for a period of twenty years, and also giving the company permission to close two streets and to move two others.

Saskatoon, Sask.—A bridge on the line of the Canadian Northern Railway was recently damaged by the breaking of one span. A number of passengers were killed in the fall and burning of the Pullman car.

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SEND FOR COMPLETE BOUND CATALOGUE

Stratford, Ont.—The committee dealing with questions relative to the street railway will make application to the municipal council asking that body to prepare and present a by-law calling for the raising of $30,000 for this utility.

Sudbury, Ont.—Mr. Chas. McCrea has made application to the legislature for the incorporation of the Sudbury Copper Cliff Railway, capital $250,000. The lines of this road are not to exceed twelve miles distance from Sudbury.

Toronto, Ont.—A report states that a company are preparing to start a motor bus line in this city at an early date. They expect to have 50 cars to start with.

LIGHT, HEAT AND POWER.

Niagara Falls, Ont.—The city has approached the Provincial Government, and the Queen Victoria Park Commission, to secure permission for the erection of a new power house and pumping station. The plans call for four generators, water-wheels, pumps, penstocks, etc., to be placed at the bottom of a shaft. The total projected development is about 4,000 horse-power, near the site of the present pumping station. Mayor C. C. Cole, and Water Commissioner R. P. Slater, are looking after the city's interests. Mr. John Kennedy, Montreal, is the consulting engineer.

Ottawa, Ont.—The charter granted to the Orillia Power Company embodied the proposal of Hon. Adam Beck, calling for the surplus of all power plants to be used in the extension of the plant making the surplus.

Quebec, P.Q.—At a meeting of the Dorchester Electric Company preliminary details of the new concern were finally arranged, and it was announced that the new concern would be generating power by Sept. 15 next. The board of directors, as elected, consists of Ald. James Robinson, of Montreal, president; the Hon. N. Garneau, of Quebec, vice-president; Dr. W. D. Hart, G. E. Tanguay, T. N. King, J. S. Bosse, F. G. Lyman and G. Proteau.

St. Thomas, Ont.—A report states that the London Electric Company has offered to illuminate the streets for $3,000 per year less than the estimate of Hydro-Electric Commission.

Toronto, Ont.—The hydro-electric commission will undertake the farm power experiments, initiated about a year ago, during the coming spring.

Vancouver, B.C.—The British Columbia Electric Railway Company will erect a sub-station at the junction of Earle road and its Westminster interurban right-of-way, to cost $100,000.

GARBAGE, SEWAGE AND WATER.

Berlin, Ont.—The municipal authorities have had their plans approved by H. G. Hodgkins, C.E., of Syracuse, N.Y., who has advised them that the water supply, if expediently used, will serve the city for the next ten years.

Lethbridge, Alta.—Mayor Hatch is interested in a proposal to construct a new filtration plant in this city. The system at present in use allows the water to become polluted, as shown by chemical and bacteriological examinations.

North Toronto, Ont.—The town solicitor will prepare a by-law for the ratepayers calling for the expenditure of $60,000 to provide a pumping plant to supply the town with water from Lake Ontario. The project to obtain a supply from certain springs at Lemmonville has been blocked by the Private Bills Commitee of the Provincial Legislature.

Sarnia, Ont.—The provincial medical health officer has recommended that the future water supply of the above municipality be obtained from Lake Huron. There has been a great deal of annoyance of late, owing to the present condition of the river intake and the bacteriological state of the water.

Sydney, C.B., N.S.—The business of the Dominion Iron and Steel Company was interrupted recently by the breaking of a large water main. The break took place in the main pipe between the blast furnace and the bessemer plant, and at a depth of 28 feet, which rendered its repairs most difficult.

BUILDINGS AND INDUSTRIAL WORKS.

Battleford, Sask.—The Battleford Curling Club expect to erect a large rink for their own use.

Calgary, Alta.—A by-law to raise the sum of $20,000 will be discussed at a meeting of the aldermen. The money is to provide an asphalt plant for the city.

Calgary, Alta.—The rough preliminaries in connection with the plans for a new police station have been completed and competitive plans will be called in a few days. The station will have accommodation for one hundred prisoners and cost about $125,000.

Edmonton, Alta.—Mr. J. H. Gariepy will erect a six-story building on the south side of Jasper Avenue, between Fifth and Sixth Streets. The estimated cost of the work is $250,000.

Fonthill, Ont.—The Dominion Canners Co. are preparing for the erection of a large cannery at this point. The plant is to be finished this year.

Fort William, Ont.—The Board of Education will call tenders for an addition to the Collegiate Institute. It is estimated that the work will cost $20,000.

Ladner, B.C.—Plans are being prepared for a new municipal hall. A by-law calling for the erection of this building will be presented to the ratepayers at an early date.

Montreal, P.Q.—A company taking the name of the Centre-Freeze Ice Company has been formed in this city to manufacture ice from sterilized water. Mr. L. O. Geoffrion, of the Montreal Harbor Board, is interested in the matter.

Montreal, P.Q.—Plans for the erection of a ten-story building on the site now occupied by the Castle Blend block are prepared. The sale of the property was concluded by Mr. John J. Louson, representing Mr. James Buchenough, who, in turn, was acting for one of the largest trust companies operating in Montreal.

Preston, Ont.—Tenders will be called for the erection of a new addition to the Public school. H. C. Edgar, Town Clerk.

Regina, Sask.—The Saskatchewan Motor Company have purchased a site on which they will commence the erection of a four-story garage.

Saskatoon, Sask.—A report states that negotiations are closed for the erection of the mills of the United Flour Mills Co., of Minneapolis, U.S.A.

Toronto, Ont.—A report is in circulation that a tall building will be erected on the site now occupied by Messrs. Rice Lewis and Company. It is said that the Standard Stock Exchange are to be the owners of the new structure.

Toronto, Ont.—The National Iron Works, Ltd., are preparing plans and specifications which, when completed, will double the present capacity of their plant. Mr. Gordon F. Perry, manager of these works, is superintending the details of these plans.

Toronto, Ont.—Work on the new St. Alban's Cathedral (Anglican) will be started at an early date.

Vancouver, B.C.—Plans for a large building are prepared. It is to be erected at 506-14 Cordova Street.

Vancouver, B.C.—A report states that the Dominion Bed Manufacturing Company may erect a branch factory in this city. There is a branch of this company in Kent, Washington, at the present time.

Vancouver, B.C.—The Dietrich Saw Works, of Galt, Ont., will establish a branch in Vancouver. A permit has been taken out for a $10,000 warehouse. It will be enlarged later.

Welland, Ont.—The Holman Sign Company will occupy the premises recently used by the Electro Steel Company. Forty men will be employed.

BRIDGES, ROADS AND PAVEMENTS.

North Toronto, Ont.—A road through the Mount Pleasant Cemetery will be constructed in the near future. An overhead bridge will be erected in connection with this over the tracks of the old Belt Line Railway. The General Burying Ground Trust and the town of North Toronto will share the cost, which comes to about $15,000. Mr. E. A. James is the town engineer of the above.

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MONTREAL ST. JOHN OTTAWA TORONTO WINNIPEG
CALGARY SASKATOON VANCOUVER VICTORIA

Province of Saskatchewan.—The Government of this province will consider the granting of $5,000,000 for road improvement.

Victoria, B.C.—Plans for a concrete bridge to replace the present wooden structure over the Gorge Road Ravine are being considered by the council. The estimate for a 60-foot span the full width of the roadway and the reinforced concrete arch with the necessary walls is $24,371. A steel bridge with a 120-foot span, having the necessary approaches at each end, the bridge taking the full width of the roadway, will cost $32,300. The engineer, Mr. Angus Smith, recommends the former.

FIRES.

Ottawa, Ont.—The establishment of Messrs. Parsons & Company was damaged by fire to the extent of $5,000 on February 9th last.

St. Catharines, Ont.—About $6,500 damage was caused by fire to the premises and stock of the Martin Electrical Store in this city.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ended February 12th, 1912. Fuller information may be obtained by communicating with the Department of Trade and Commerce, Ottawa.

The following were among the enquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending March 4th, 1912:—

A Dundee firm of jute manufacturers wish to appoint a reliable Canadian agent.

A Scottish firm manufacturing split lentils are anxious to develop trade connections in the Canadian North-West.

A London firm manufacturing automatic packing machinery would like to hear from Canadian firms likely to be interested.

Enquiry is made by an English manufacturer for the names of parties in Canada having alkali properties to dispose of.

A London correspondent is desirous of purchasing Monel Metal, and would like to hear from Canadian manufacturers.

A West of England correspondent is open to represent Canadian firms desirous of doing business in Great Britain.

A Scottish firm manufacturing a new improved diaphragm suction pump are open to appoint Canadian agents.

From the branch for city trade enquiries, 73 Basinghall Street, London, E.C.:—

A Midlands firm manufacturing horticultural brass foundry (syringes, pumps, sprayers, etc.), invite correspondence from Canadian importers.

CURRENT NEWS.

Calgary, Alta.—Many tenders were received for the municipal paving. The prices ranged from $2.36 to $2.85 per sq. yd. for bithulithic; $3.50 to $3.75 for wood blocks; $2.05 to $2.40 for sheet asphalt; $2.12 for asphalt concrete, and .09⅛ to 10¾ for concrete sidewalks.

Calgary, Alta.—The municipal authorities are preparing to spend the sum of $84,000 on park improvements during the coming season. The plans call for the construction of asphalt walks and driveways, the erection of band stands, electric lighting extensions and the installation of two or more fountains.

Ottawa, Ont.—Over 100 dwelling houses belonging to the C.P.R. and situated near the old St. Lawrence and Ottawa tracks on the block bounded by McTaggart, Redpath, Cumberland and Dalhousie Streets, were condemned by the medical health officer as the result of not being equipped with sanitary conveniences. The C.P.R. was instructed to install improvements, but this would have required running a sewer down the street, and to this expense the company was not prepared to go. As a result the houses will all be knocked down, the material in them being sold to the highest bidder.

Ottawa, Ont.—Railroad officials are to make a request to the federal government that steel rails from the United States be admitted into Canada duty free during the coming year, owing to the inability of Canadian makers to supply the demand.

Toronto, Ont.—An architectural competition will take place in connection with the new Technical School to be erected on Harbord Street. Plans must be in the hands of the committee of awards previous to June 15th next. Although the treatment will be left to the discretion of the designers, a few suggestions have been made. Among these it is stated that good light is important; brick material is recommended for the facades and the structure is to be five stories in height. The board of assessors has been thus named:—Dr. A. C. McKay, principal of Toronto Technical School; Mr. P. E. Nobbs, of McGill University, and Mr. Frank A. Wickson, Toronto.

Vancouver, B.C.—The Wallace Shipyards, North Vancouver, has received instructions to fit the tug Point Grey with oil-burning apparatus, and also an order from the Terminal Steamship Company to fit the sternwheeler Baramba with oil fuel apparatus.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16094—March 6—Authorizing G.T.P.B.L. Co. to construct spur for Yellowhead Pass Coal & Coke Co., Ltd., on Alberta Coal Brch.

16095—March 7—Authoriing C.N.O. Ry. to take portion of Lot 9, Brokenfront Con. Town of Trenton, for diversion as approved by Order 12480.

16096—March 6—Authorizing Midland Rly. (G.N.R.) and G.T.P. Ry. to operate trains over crossing in Parish Lot 55, St. Boniface, Man., pending completion of interlocker.

16097—March 8—Authorizing G.T.R. to construct branch line of railway through Holmedale District in City of Brantford, Ont., and across Hydraulic Canal and the Grand River to a connection with its Brantford and Tillsonburg Branch (20th Dist.) and to close streets and highways in the city. Compensation to be paid A. J. Wilkes for land taken.

16098—March 11—Approving revised location of C.N.O. Ry. (Montreal-Port Arthur line) through Twp. of Capreol, dist. of Nipissing. Mileage 426.53 to 429.29 from Montreal.

16099—March 9—Substituting plan "A" for plan filed and approved by Order 15280 of Sept. 11th, 1911, C.N.R. spur H.B. reserve in city of Edmonton, Alberta.

16100—March 9—Authorizing Central Vermont Ry. to reconstruct bridge over Little Montreal River, between St. Lambert and Chambly, Que.

16101—March 9—Directing C.P.R. within 90 days to install electric bell at crossing known as Concession Road between Cons. 4 and 5 in Twp. of Cumberland, County Russell, Ontario.

16102—March 4—Authorizing C.P.R. to construct subway at Decarie Ave., Montreal, Que., to include diversion of Prudhomme Avenue by means of Western Avenue, $10,000 from Rly. Grade Crossing Fund, one-fifth of balance by city of Montreal.

16103—March 7—Directing G.T.R. at once to arrange that train No. 7 stop at Paris, Ont., to let off passengers from Toronto and points east thereof; complaint Board of Trade, Paris, Ontario.

16104—March 11—Authorizing C.P.R. to use and operate bridges at mileages 0.5, 94.3 and 81.4, Windsor sub-division.

16105—March 11—Authorizing C.P.R. to use and operate bridges at mileages 40.3, 42.1 and 43.8, on London sub-division.

16106—March 11—Authorizing C.N.O. Ry. to cross public road in Twp. of Trafalgar, county of Halton, Ontario.

16101—March 14—Dismissing application of United Fruit Co.'s of Berwick, N.S., on rate of apples to Winnipeg, Man.

THIS CANCELS FORMER SUMMARY OF ORDER NO. 16101.

16107—March 11—Approving by-law of Bay of Quinte Ry. authorizing Geo. H. Shaw to prepare and issue tariffs of tolls.

16108—March 7—Directing G.T.R. to before May 1st, 1912, install electric bell at crossing west of Bainsville station, Twp. of Lancaster, Ct. Glengarry, Ontario. 20 per cent. from Railway Grade Crossing Fund.

16109—16110—March 12—Authorizing C.P.R. to use and operate bridges 8.2 and 9.2 on Cranbrook S.D. and bridges 80.5 and 62.8 on its Sirdar sub-division.

16111—March 4—Authorizing G.T.R. to take lands in the Twp. of York, county of York, Ont., in connection with Toronto grade separation scheme.

16112—March 5—Relieving G.T.R. from further protection of crossing of Richmond Road, Twp. of Nepean, Carleton Ct., Ont.

16113—March 4—Approving standard station designs for Algoma.

16117—March 4—Eastern Railway Company, and for Algoma Central and H.B. Ry.

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The Canadian Engineer

An Engineering Weekly

STEREOGRAPHIC MEASUREMENT.

By C. R. ANDERSON, M.A., Associate Professor of Photography, University of Toronto.

The problem of deducing measurements from a photograph is the inverse of that of producing a perspective drawing from the known dimensions of an object, for the image produced by the lens on a photographic plate is a true perspective if the lens be free from spherical aberration and astigmatism.

If the plate be assumed vertical then the nodal point of the lens is the point of view, the plate is the picture plane, and the focal length of the lens is the distance line. The optic axis of the lens intersects the plate in the principal point and a horizontal line drawn through this point is the horizon of the perspective. Having given the horizon line of a photograph the principal point and the distance line, that is the focal length of the lens, the problem of estimating the object in all its parts is, however, indeterminate, for we have two unknown quantities, viz., the distance of the object and its dimensions, which are dependent on each other. But if we are provided with two perspectives of the same object from suitable stations, the problem may be solved by plane table methods.

The use of photographs in surveying dates back as far as 1858 or 59, about which time Colonel Laussedat executed numerous experimental surveys with the camera, the results of which were communicated to the Academy of Sciences and received the endorsation of that body. Subsequently the method was taken up by Meydenbaur in Germany, and was used to some extent in military work during the Franco-German war, later it was exploited by Finsterwalder, Koppe, and others. It was also used in Austria, Sweden, Switzerland and Italy during the seventies and eighties. Perhaps the most extensive work by the photographic method was in the Rocky Mountain survey and the Alaska boundary delimitation (Canadian section) under Deville, Surveyor-General of Dominion Lands; this work was begun in 1888 and continued up to about 1897, and was most successful.

In all this work extending over a period of 30 or 40 years the methods employed for reduction of the photographs, though differing much in detail, were all what may be fitly termed **monocular**; that is to say, a single photograph was in itself a unit and the determination of any magnitude was arrived at by the comparison of two or more units. The various methods are all somewhat intricate and laborious, and, moreover, the identification of terrestrial details as viewed from two or more stations at different angles is often very difficult. Again, the method is not self-contained, for the camera stations and other central points must be determined by triangulation or other extraneous method.

This plan of taking a single photograph as a unit is analagous to that of a man who views an object with one eye closed and then moves to a new view point and makes a similar observation, instead of using both eyes from one station. It seems all the more remarkable that the binocular method was not introduced when the plastic properties of a stereograph were so well known; for the invention of the stereoscope dates back to 1838.

The first suggestion of utilizing stereoscopic photographs for measurement of distance by means of a comparator seems to have been made by Dr. Pulfrich, of the scientific staff of the Zeiss works, in 1901. (See "Naturwissenschaftliche Rundschau," 16, p. 589. From that time on numerous articles have appeared in scientific periodicals dealing with the problem and meantime the firm of Carl Zeiss has steadily improved the original apparatus until a permanent form of both camera and comparator have now been reached, both of which are of great perfection.

In this paper I purpose to deal with the question of measurement only, assuming that means have been used to secure accuracy in the setting of the camera.

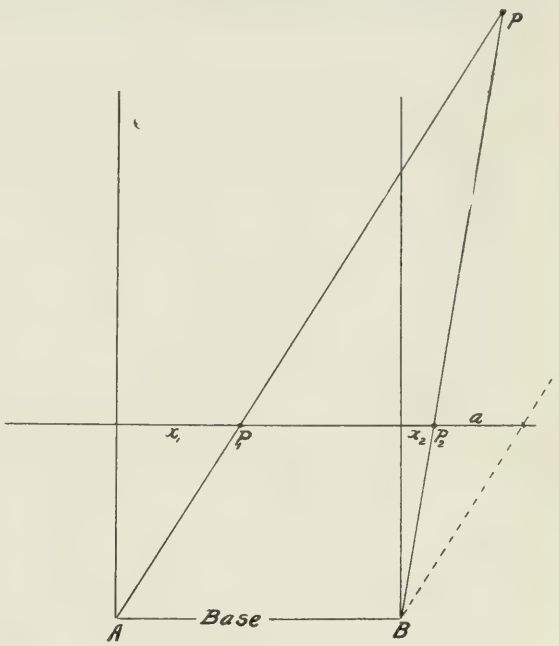

Fig. 1.

Consider a single photograph and let lines be drawn on it representing the horizon and principal line of the picture. This will divide the photograph into quadrants and the coordinates x and y of any point therein may be measured by means of a comparator. The actual values of these quantities cannot, however, be determined until their distances from the station are measured and this distance may be obtained from a stereoscopic pair.

The method of measuring the depth of field to any point from a stereograph requires a linear measurement of the parallax of that point. The relation between parallax and depth of field may be illustrated by the accompanying diagram, Fig. 1.

Let A and B be the two points of observation, and let P_1 and P_2 be the images of the distant point P on the picture plane, then x_1 is the ordinate of left image, and x_2 of the right and the difference between AB and P_1 P_2 is the parallax and is obviously equal to $x_1 - x_2$. Let the parallax be denoted by a, equal to the algebraic difference of the ordinates. It is clear that when the parallax a equals O the point P must be at infinity, and that a increases as P approaches AB, also that all points lying on a vertical plane through P parallel to AB have the same parallax.

Fig. 2 exhibits the parallax of various points in an actual stereograph. The base of the pair of photographs was 2.438 m. and the focal length of the lens was 141 mm.

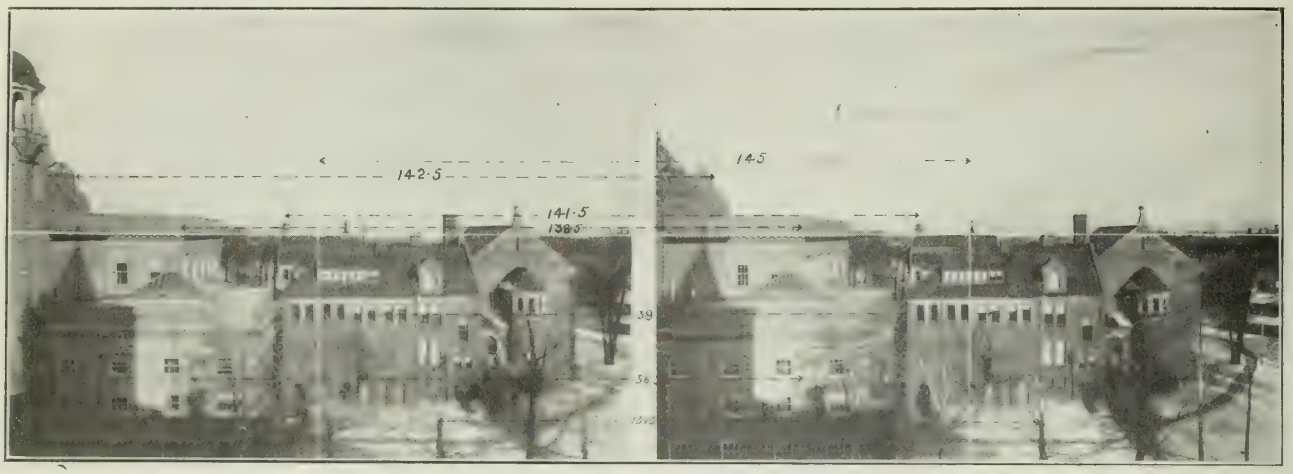

Fig. 2.

Base = 2.438 metres, f = 141 mm.

As the picture is mounted the base is represented by a distance of 145 mm., and the distances between various pairs of points are shown on the figure, from which it is seen that the nearer the points lie to the station the greater the parallax. It must be observed, of course, that the parallax is not a measure of the distance directly to the distant point, but a measure of the perpendicular distance between two vertical planes, one of which passes through the station points and the other through the distant point parallel to the first, in other words the "Z" of a rectangular system of co-ordinates.

In the taking of the photographs it is necessary that the plates be vertical and that they lie in one plane; the stations may be on the same or different levels. The length of the base and the focal length of the lens are required. By convention the left station may be conveniently taken as the point from which measurements are to be made, hence the co-ordinates x and y will be measured from the left plate and the parallax from both.

It now remains to show how the actual co-ordinates of a point in space may be determined from the co-ordinates as measured on the stereograph. In Fig. 3:

Let P be the point whose position is to be determined and which is represented on the plates by the images P_1 and P_2; let the ordinates of these points be x and x^1, (x^1 being negative), let B be the base and f the focal length of the lens. Then, from similar triangles it is evident that Z the distance of a plane through P $= B \frac{f}{x + x^1}, = B \frac{f}{a}$

$$\text{also } X = Z\frac{x}{f}$$

$$\text{and } Y = Z\frac{y}{f}$$

mirrors M_1 and M_2. Each plate may be rotated in its own plane by screws S_1 and S_2, so that the horizons of the two plates may be accurately adjusted. Also, the right plate P_2 may be moved parallel to its length by the screw H so as to

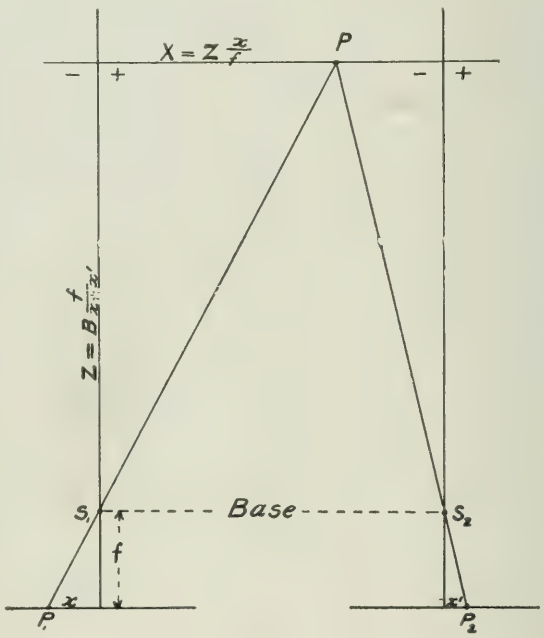

Fig. 3.

compensate for difference in level of the two stations. In the optical planes of the microscope are two balloon marks which appear to coincide when the instrument is in accurate adjustment and may be set so as to apparently coincide with any point on the stereograph whose position is required.

Fig. 4 shows the latest model of the stereo-comparator destined for the precise measurement of stereographs, one of which has lately been added to the photographic equipment in the University of Toronto. The instrument is provided with a binocular microscope magnifying eight times, of which the objectives are shown by O_1 and O_2, the eye pieces by E_1 and E_2. The microscope may be focussed on the plates by a screw not visible in the figure, and the eye pieces may be separately adjusted to compensate differences in the eyes of the observer and are also adjustable to different interocular distances.

The plates P_1 and P_2 are rigidly held in place by metal clamps, and are illuminated from beneath by adjustable

The screw A moves the entire bed plate, carrying both plates to the right or left, and its movement is indicated on the scale X. the screw B moves the microscope at right angles to the bed plate, and its motion is indicated in the scale Y, and the screw C moves the right plate to the right or left independently of the other plate, and its movement is indicated by a scale and divided screw head Z. All three scales read to 1/50 mm., and by estimation to 1/100 mm. Thus, by means of the scale X the distance of any point to left (+) or right (—) of the optic axis is measured by means of Y the height of any point above (+) or its depth below (—) the horizon is measured, and lastly, by means of Z the parallax of any point is determined. From these three measurements made on the photographs the actual co-ordinates in space are at once determined by means of the simple formulas already given.

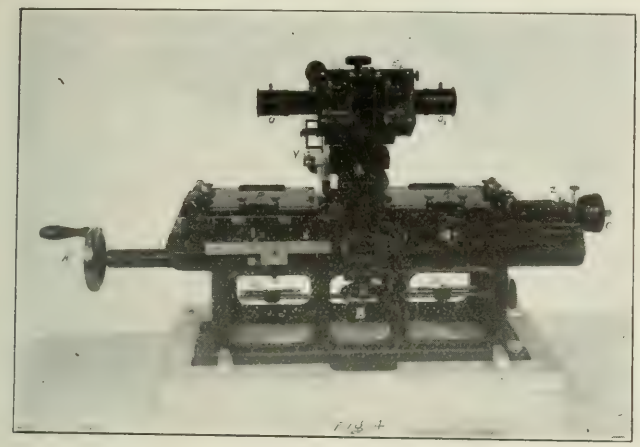

Fig. 4.

The great simplicity of this method as compared to that of plotting by means of the plane table will be at once apparent, and the precision secured is much superior and comparable to that of any other method of survey in ordinary country, while in mountainous districts it ensures results that cannot otherwise be secured except at very great cost.

The application of photogrammetry to stereographs is not confined to survey work alone, but may be used for any purpose where measurement is required. For example, if two cameras are used and simultaneous exposures are made the method becomes applicable to moving objects, and may be employed to indicate the position at any instant of military forces during manoeuvres in the field or of vessels at sea, or to determine the altitude of clouds, aeroplanes or the flights of birds. In a similar way the method becomes readily applicable in astronomy. In architecture it may be employed to examine and measure details which are not readily accessible. Again, the method may be modified by taking two photographs from the same point at different times when any changes in the view will be at once made evident, this will find application in estimating relatively small changes, such as glacier motion, local variations in contour of the earth's surface, subsidence of structures, progress of earthworks, etc., or in the direction of spurious coins or counterfeit bank notes.

At the close of the construction season of the present year the Grand Trunk Pacific and its ally, the National Transcontinental, will be in a position to carry telegraphic despatches from 150 miles west of Yellowhead Pass to Cochrane, a point 900 miles east of Winnipeg, a distance of 1,975 miles, over its own lines. Besides this the Grand Trunk Pacific will build over 700 miles of telegraphic lines on branch lines and, from the Prince Rupert end of the Grand Trunk Pacific, a total of 830 miles in all.

THE PRACTICAL DESIGN OF REINFORCED CONCRETE FLAT SLABS.*

By Sanford E. Thompson.†

The purpose of this paper is to present material covering the practical task of designing flat slab floors for reinforced concrete structures. The requisite thickness of slab, amount of reinforcement, and size of column head, for different loadings and different spans, are given in a table; and the theories and assumptions involved in the computation are briefly discussed. Values not included in the table may be worked out from the formula, finding the desired values of C_s and Ce from the diagrams.‡ Curves are given also for the constants used in the design of members with steel in top and bottom, and apply not only to flat slabs, but to any beam or slab reinforced both in compression and tension.

For reinforced concrete buildings, the flat slab, or girderless floor,—as it is sometimes called,—is as cheap, and frequently cheaper, than beam and girder construction. The smooth ceilings with no intersecting beams allow better distribution of the light. The expense and complication of installing sprinkler systems is lessened. The clear headroom for the same story height is increased, or else, on the other hand, the story height may be made less without reducing the effective headroom. This last consideration alone is often important enough to dictate flat slab floors.

With flat slab floors the entire load is supported directly on the columns, which are usually spaced about equally in both directions. The column heads are enlarged so as to give increased resistance in shear and bending at the points where this is most needed. The reinforcing bars run through the slabs over the column in four directions, two rectangular and two diagonal.

The simplest way of considering the flat slab is to assume that a portion of the slab extending a certain distance out from the column is a flat, circular plate, similar to a Japanese parasol, but with no slope to its surface. This plate is fixed to the column and is assumed to extend out from it on all sides like a cantilever as far as the line of inflection of the slab, which line,—as in other forms of monolithic construction,—is about one-fifth of the net span away from the support. The rest of the slab may be considered as entirely separate from the flat circular plates but simply supported from their outer edges or circumferences.

This is no new theory, but is somewhat similar in effect to that of a uniformly loaded, fixed or continuous beam. To illustrate this in practical fashion, we will take an ordinary beam uniformly loaded and fixed at both ends. This illustration does not in any way show the methods of determining a bending moment in the flat slab, since, as stated below, the actual bending moment is dependent upon the elastic theory. It does, however, show quite clearly that we are justified in assuming the slab to be cut through on the line of inflection.

We know from simple mechanics that the moment at the support of an ordinary or uniformly loaded or fixed continuous

* Presented at the eighth annual convention of the National Association of Cement Users, March 11-16, 1912, Kansas City, Mo.

† Consulting engineer, Newton Highlands, Mass., U.S.A.

‡ For an example of flat slab design worked out in detail see Taylor and Thompson's "Concrete, Plain and Reinforced," 2d edition, 1911, pages 487 and 488.

beam is Wl/12* and, at the centre, is Wl/24. Now, suppose at the points of inflection, which also by mechanics we know to be located at a distance 0.2113l from each support, we cut the beam completely through so as to have a cantilever at each end with a simply supported beam between. The bending moment of the cantilever at its support, due to the load upon it, is $0.2113W \times 0.2113l/2$, and the moment at its support due to the load on the supported beam between cantilevers, is $\frac{[1-2(0.2113)]}{2} W \times 0.2113l$. The sum of these two moments is $0.0223Wl+0.0610Wl=0.0833Wl$ or Wl/12. In other words, while this analysis is not that which can be used for a flat slab, because of the extra strength of the flat slab due to the multiple reinforcement, the division into sections corresponds to our assumption in the flat slab theory. In the same way we might show that the centre moment of the simple beam supported by the two ordinary cantilever beams is Wl/24.

Tests of the flat slab construction at Minneapolis† indicate that the line of inflection of a flat slab floor is substantially the same as in a fixed beam, or about 1/5 the net distance between supports, although, as would be expected, the bending moment is entirely different.

Problems of Design.—The problem of the design of the flat slab, then, resolves itself into (1) a determination of the proper thickness and reinforcement required at the support for the cantilever circular plate supporting its own load and also the load of the rest of the slab, and (2) a determination of the thickness and reinforcement at the centre of the span required for the simply supported section lying between the circular plates.

Various Methods of Design of Slab.—Various methods have been advanced for the design of the flat slab. Some are based merely on deflection tests, which give no true basis for computations; others compute the steel carefully at the centre of the slab, which is not the critical part; others consider the construction to consist of beams between columns with a slab between, thus obtaining ultra-conservative results; while a plan still more common is to take the moment at the suports arbitrarily without regard to the size of the column head. The shear or diagonal tension near the column head is frequently disregarded altogether.

Shear at the Support.—The direct shear at the support, as in any mechanical construction, is equivalent to the total load supported by the column. This shear is readily borne by the concrete and steel. The diagonal tension, however, which, as in a beam, may be considered as measured by direct shear, must be carefully considered. To reduce the diagonal tension and also to increase the resistance to bending of the slab, the column head is enlarged. To still further increase the resistance, a part of the bars in the top of the slab over the supports may be bent down just outside of the supports and then carried along in the bottom of the slab.

In either case, the shearing stress should be limited to definite units, although it seems permissible to use a somewhat higher stress than in a beam.

The diameter of the enlarged column head, which is the actual support of the slab, should be governed by the shearing stress either at its circumference or at a short distance outside of it.

Bending Moment at Support.—The theory of flat plates, which must be used in designing a circular plate, is not yet clearly established. By the use of what is termed, in mechanics, the elastic theory, we have a fairly good working hypothesis. The analysis solved by Prof. H. T. Eddy* offers, in the writer's judgment, the most rational solution of the problem yet advanced

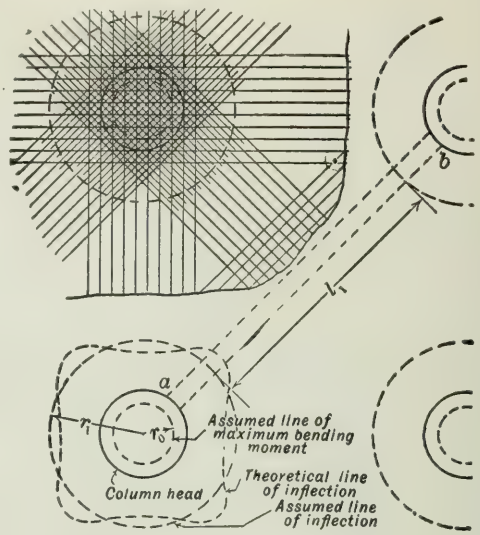

Fig. 1.—Plan of Flat Slab.

In the design of the flat slab, therefore, the author† has started with Prof. Eddy's analysis of stresses in a homogeneous circular plate, and from his general formulas has deduced by mathematics other formulas applying to circular plates free on their edges and clamped around the columns In a flat slab thus supported there are horizontal stresses at right angles to each other. The effect of these lateral stresses has been taken into account, this being expressed by Poisson's ratio, which is the ratio of the lateral deformation to the deformation in the direction of the stress

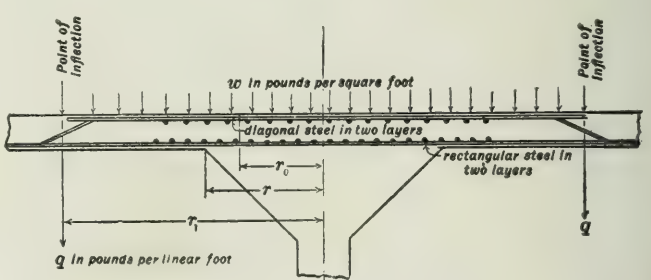

Fig. 2.—Section of Flat Slab.

The value of this ratio is taken as 0.1, which has been shown by experiments to be a fair value for concrete of 1:2:4 proportions.

It has been found possible to reduce the complicated formulas derived by the Eddy analysis into four formulas which are comparatively simple although still rather complicated for practical use. These formulas are for four bend-

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* W = total live plus dead load. l = distance in feet between supports.

† See papers on "A Test of a Flat Slab Floor in a Reinforced Concrete Building," by Arthur R. Lord, Proceedings National Association of Cement Users, Vol. VII., page 156.

* Engineers' Society, University of Michigan, 1899.

† The author is indebted to Mr. Edward Smulski for the computations involving intricate analyses by higher mathematics; also to Mr. John Ayer for further studies in the practical design.

ing moments and can be applied not merely to the slab at the support, but to any point in the circular plate surrounding the column. The four moments are as follows:

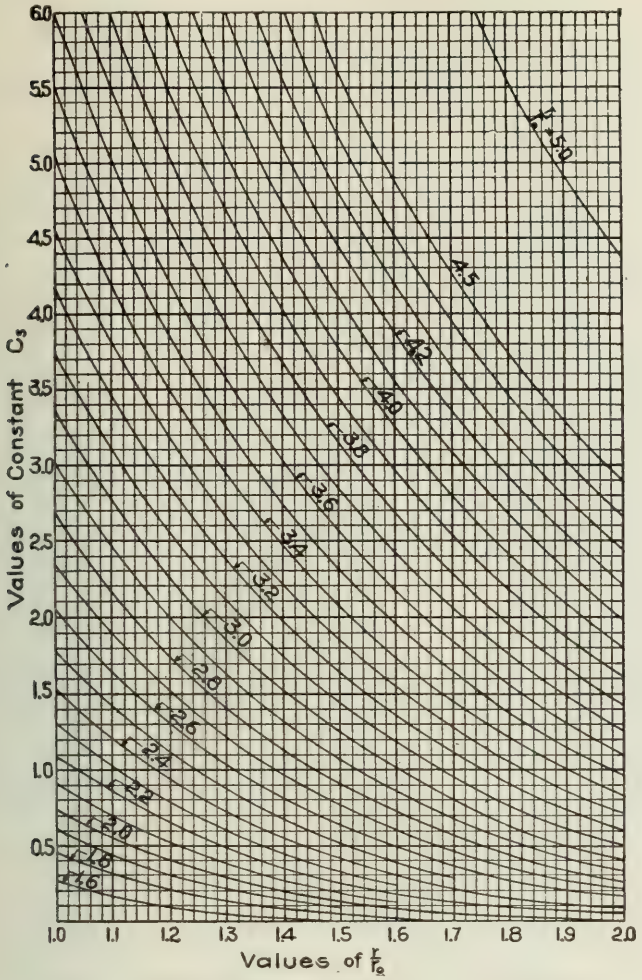

Fig. 3.—Diagram Giving Values of C_s in Formula.

M_1 = moment produced by the loading that is uniformly distributed over the circular plate and causes circumferential fibre stress.

M_2 = moment produced by this same loading but which causes radial fibre stress.

Ma = moment produced by the loading from the rest of the slab that is distributed along the outer edge of plate, and causes circumferential fibre stress.

Mb = moment produced by the latter loading but which causes radial fibre stress.

A study of the analysis, however, shows that the two circumferential moments are a minimum at the support and may be safely disregarded. The two formulas for the radial moment may be combined and still further reduced to the following simple form which can be used for a circle of any radius, r, within the circular plate. The meaning of the symbols is made clearer by reference to Figs. 1 and 2, which show the plan and the section of a flat slab.

Let

q = uniformly distributed load around the outer edge of the plate in pounds per foot of length.

w = uniformly distributed load on surface of plate in pounds per sq. ft.

r_0 = radius in feet to line of maximum bending moment (which is within the column head).

r_1 = outer radius of assumed plate in feet.

r = any radius in feet where moment is to be computed, for critical section, r is radius of column head.

C_s, Ce = constants given in Figs. 3 and 4.

Mr = total radial bending moment to be used ordinarily.

l_1 = distance in feet between lines of inflection.

Then total radial moment at any point of plate is

$$Mr = wr_0C_s + qr_0Ce$$

For convenience in computation, values of the constants C_s and Ce, for various values of the ratios r_1/r_0 and r/r_0 are plotted in the curves given in Figs. 3 and 4.*

$$Mr = w\,r_0^2C_s + q\,r_0\,Ce$$

r_0 = radius in feet to line of maximum bending moment.

r_1 = outer radius of assumed plate in feet.

r = any radius in feet where moment is to be computed; for critical section, r is radius of column head.

$$Mr = w\,r_0^2C_s + q\,r_0\,Ce$$

r_0 = radius in feet to line of maximum bending moment.

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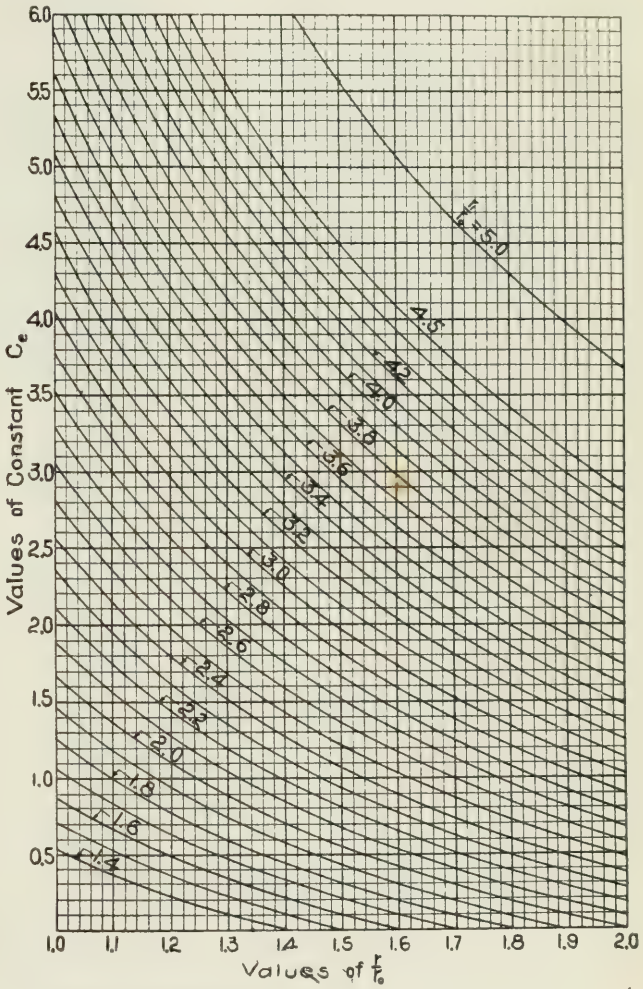


Fig. 4.—Diagram Giving Values of Ce in Formula

With q expressed in pounds per foot of length, w in pounds per square foot, and r_0 in feet, the moments are in foot-pounds per foot or inch-pounds per inch.

Position of Maximum Bending Moment and of Maximum Stress.—As commonly constructed, the column head flares at the top and is therefore more or less flexible. For this reason the line of maximum bending moment will be located, not at the extreme edge of the column head, but a little

* These are drawn up from values in tables in Taylor and Thompson's "Concrete, Plain and Reinforced," 2d edition, 1911, page 518.

within it. The maximum stress, on the other hand, will not be on the line of the maximum bending moment because the strength there (since it is within the head) is increased due to the greater depth of concrete. It is fair to assume, therefore, that the maximum stress is at the edge of the column head, and we may assume the "critical section" as on this line. The exact location of the line of maximum moment is indeterminate. Under ordinary conditions it appears fair to assume its location as within the column head, a distance equal to the thickness of the slab. Therefore, Mr is figured for a value of $r = r_0 + t$. In figuring this moment, values of the constants C_s and Ce should be taken from the curves in Figs. 3 and 4. As in an ordinary fixed beam, this bending moment is negative, so that the upper side of the slab is in tension and the lower in compression. Having found the moment, the design of the reinforcement and the thickness of the slab may be worked out as for an ordinary beam.

The curves in Figs. 5 to 8 inclusive will be found of assistance in working out the design.

Steel in Column Head.*—The slab at the column head might be designed with the steel all in the top of the slab running in four directions provided the slab is thick enough so that the concrete will not be overstressed in compression. In order to reduce the thickness of the slab and therefore save the additional cost and weight of concrete over the entire floor, it is economical to place steel in the bottom of the slab as well as the top, and figure it as assisting the concrete to take compression. Since a portion of the bars need to extend only far enough beyond the column head to furnish suitable bond, the cost of this additional steel will be much less than the cost of an additional thickness of concrete over the entire slab.

To make it easy to place the concrete and also to bring the entire gravity of the steel as near to the surfaces of the slab as possible in order to give the longest moment arm, and thus a thinner slab, two layers of steel may be placed in the top of the slab and two layers in the bottom. The relation of the quantity in the top and bottom must be determined by the design. If a thin slab is desired, even more steel may be placed in the bottom than in the top. In the tables, three ratios of steel are given and the percentages selected are those that will give the required working stresses in the concrete and the steel.

The Minneapolis test already referred to shows that not only the steel directly over the column head, but the steel for a considerable distance each side, takes tension. In view of this test and of the tests made at the University of Illinois,† it is safe to assume that the steel may be spaced over a distance at least equal to the diameter of the column head plus three times the thickness of the slab.

The determination as to whether the diagonal or rectangular steel should be placed at the top is governed by the relative quantities of each. More steel is required for the diagonal direction through the slab, hence the layers which are largest in section may be run diagonally.

Agreement with Minneapolis Tests.—By our theory it is possible to compute the stresses not only next to the column head but at any point in the slab. In several cases, knowing the exact location of the points where the deformations were measured in the Minneapolis tests, we have computed the stresses at these points. Using 5.6 in. as the moment arm, and including the radial bars as assisting to take tension, we figure the maximum stress in the steel over the edge of the column as 25,000 lb. per sq. in. under the normal load of 225 lb. per sq. ft. as compared with 20,700 lb. per sq. in. given by Mr. Lord as the actual maximum stress in the floor. This is no greater difference than there ought to be between design and test and shows our method to be slightly more conservative than the actual test.

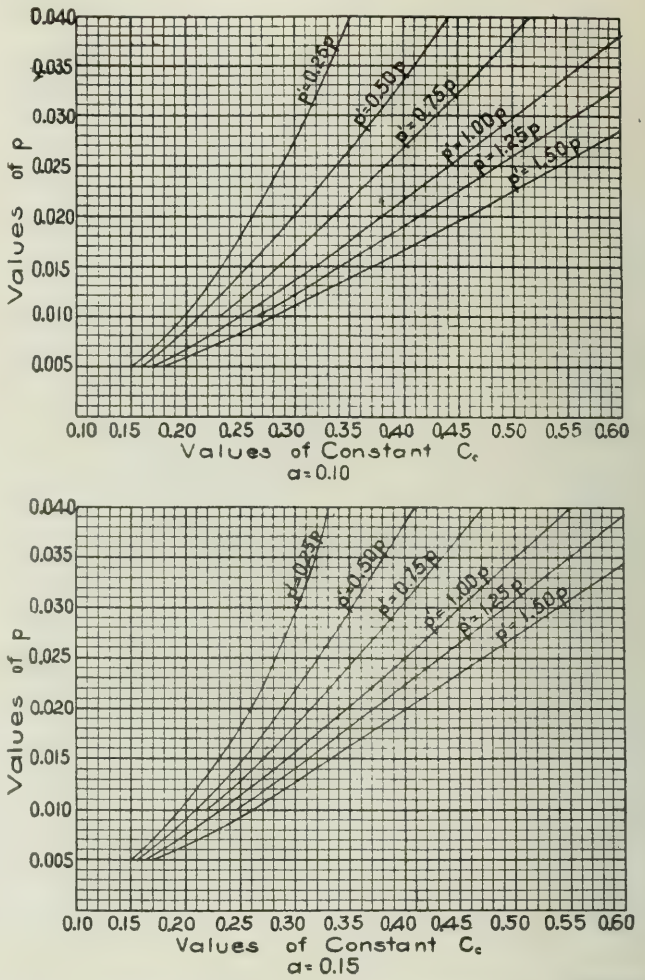


Fig. 5.—Diagram Giving Values of Constants in Formula.

$$f_c = \frac{M}{C c b d^2} \quad \text{for } a = 0.10 \text{ and } a = 0.15$$

$$a = \frac{\text{Depth of Steel in Compression.}}{\text{Depth of Steel in Tension.}}$$

$$p = \frac{\text{Area of Steel in Tension.}}{\text{Area of Concrete above Steel.}}$$

The compression in the concrete is more difficult to check since the exact locations of the test points are not given. Computations, however, show unquestionably that our methods are conservative enough to allow for the irregularities in concrete mixtures, and the danger of not having perfect concrete at the critical section.

(To be continued.)

Calgary street railway receipts for the month of February show an increase of almost 100 per cent. over the receipts for the same period last year. Last year's earnings amounted to $19,383.21. The figure this year reaches a total of $37,545.45.

* Certain features of flat slab reinforcement are covered by letters patent No. 1,003,384 of C. A. P. Turner.

† See paper on "A Test of a Flat Slab in a Reinforced Concrete Building," by Arthur R. Lord, Proceedings National Association of Cement Users, Vol. VII., page 182.

AN ELECTRICAL ADDITION TO A STEAM PUMPING PLANT.

The northern section of the city of Toronto has been the scene of great residential building operations during the past few years. At a point about three miles north of the water-front the land rises abruptly to a height of one hundred and fifty feet at places, and upon this ridge many high-class residential districts have been opened.

The main pumping station is situated at the foot of John Street, almost at the water's edge, and in order to relieve the work of this plant a high level station was constructed. The original plant consisted of two pumps operated by two steam engines of the Corliss type; these pumps possessed a pumping capacity of 7,500,000 gallons per twenty-four hours, and were installed in the year 1890.

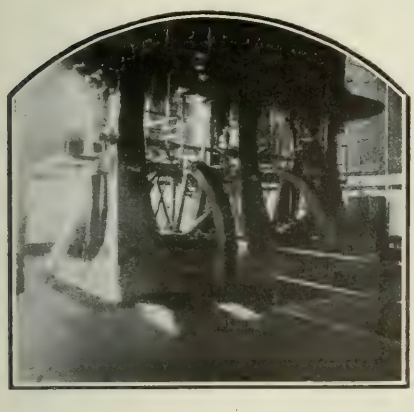


Fig. 1.

In 1905-08 these pumps were found to be greatly overtaxed and two compound units, one of which is illustrated by Figure 1, were installed. The combined pumping capacity of the plant was then increased to 19,500,000 gallons per twenty-four hours.

About eighteen months ago the water consumption of the city showed the necessity of again increasing the capacity of the northern station; this time, however, the former policy of strengthening the steam units was abandoned.

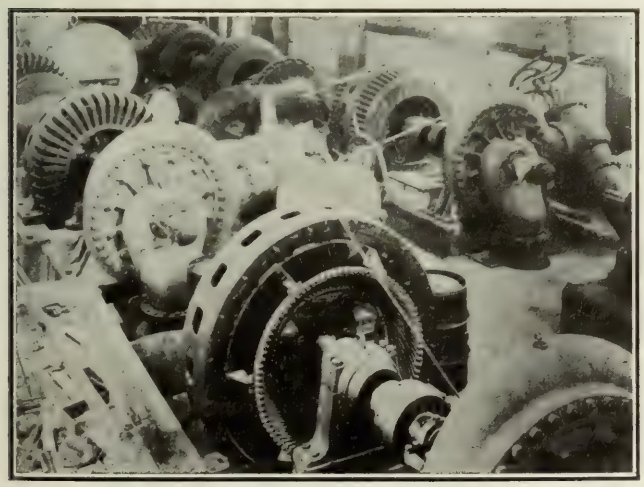


Fig. 2.

Three years ago the municipality voted in favor of adopting the hydro-electric policy. During the construction of the various sub-stations, etc., required before the high pressure current of 110,000 volts could be lowered to such pressure as would allow it to be employed for domestic purposes, it so happened that the electrical engineers selected a site on which to erect the north step-down sub-station, directly adjoining the above mentioned pumping plant.

After due consideration, the waterworks engineers decided to increase the capacity of the high level station by installing electrically operated centrifugal pumps; also to increase the pumping facilities to such an extent that they would be adequate for many years to come.

At present the addition presents the appearance indicated by Figures 2 and 3, which illustrate the equipment and give a fair idea of the undertaking.

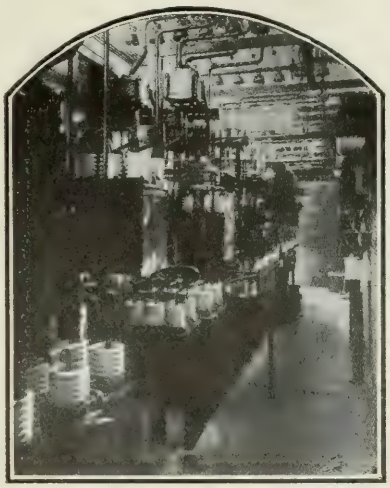


Fig. 4.

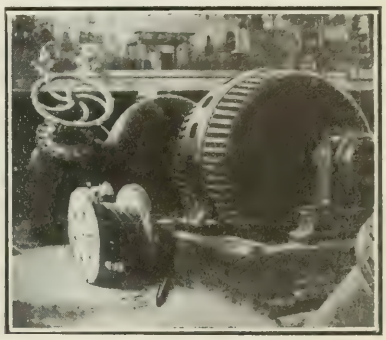


Fig. 5.

A synchronous motor is an alternating current dynamo operated as a motor, and although somewhat complicated to start, as compared to motors of other types, runs at a perfectly constant speed at all loads, providing that the operating current does not change its factors. Synchronous motors are designed to operate on single-phase or polyphase circuits; as a rule, however, they are confined to the single-phase mode of driving.

Synchronous motors are so named owing to their ability to operate in synchronism with the source of current supply. When a synchronous motor is operating without load, the field current may be so regulated that the current consumed by the motor is almost nil; its counter e.m.f. is almost sufficient to oppose the intake. This allows the motor to operate when not loaded for short periods without seriously affecting the operating costs and also does away with the trouble of starting.

When starting the motors of this type in the plant in question an auto-transformer is made use of. The current on the primary is under pressure of 2,200 volts; the secondary is so connected that a pressure of 440 volts is used to drive the current through the rotor or moving portions of the machine, when the motor speeds up the pressure is raised to 880 volts, then to 1,600. When this voltage is arrived at the machine is running at almost full speed and another switch throws the transformer out and the full voltage (2,200) through the rotor and stator. The direct current from exciters at 125 volts passes through the stator during starting.

During the operation of starting the outlet valves of the pump are closed and the water churns around in the pump;

when the motor is operating across the high tension mains the outlet valve is opened and the unit is in operation. For a steady operation during a fluctuation in the pumping the synchronous motor is very desirable.

The induction motors are started by the operating current under full pressure (2,200 volts) but their operation is very unsteady and disturbs the step-down station to a more or less extent.

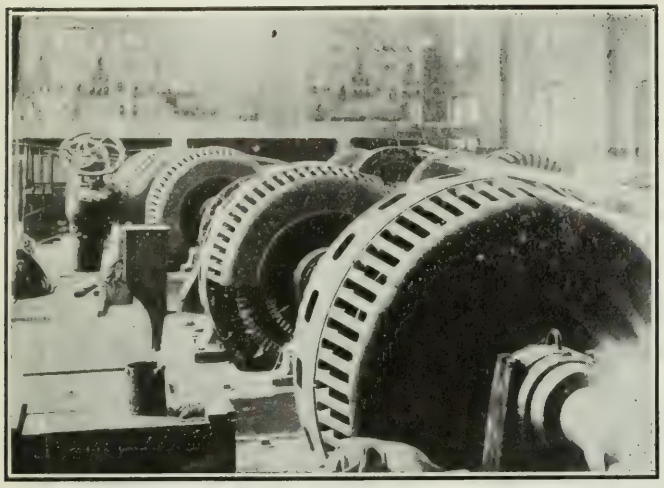
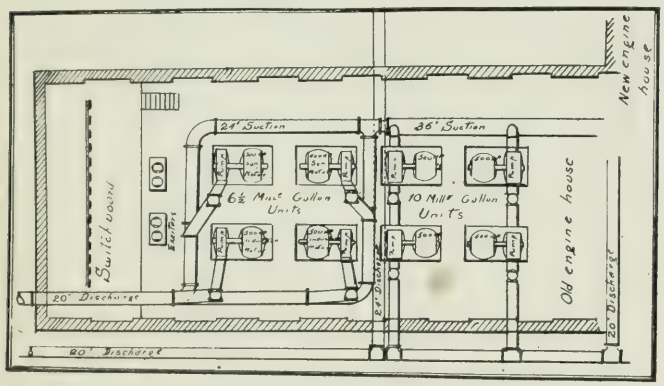


Fig. 3.

These pumps are eight in number, four having a capacity of six and a half million gallons and the balance a capacity of ten million gallons each. The combined capacity of the new addition is sixty-six million gallons per twenty-four hours. When the units are completed the capacity of the combined electrical and steam units will be 85,000,000 gallons.

The switch-board, seen in the rear of Figure 3 and in Figure 5, has control of the entire mechanism, including the opening and closing of the gate valves; motors of one horse-power being geared to the various valves and water controls. Means of operating these by hand have also been provided, as shown by the large valve wheels in some of the cuts,



particularly in Figure 5, which illustrates one of these units. The valve wheel for this pump is between twenty-four and thirty inches across.

The motive power which drives the pumps is supplied by induction and synchronous motors, each of five hundred horse-power. The design has been so prepared that the induction motors occupy the south half of the building and the synchronous motors the northern portion. The division of the pumps, however, is not similar; the six and a half million units being placed in the western half, while the ten million gallon units occupy the eastern side of the new wing. It will be readily seen that this division of pumps and motors provides that the pumps of the lesser capacity are driven by two induction and two synchronous motors. This is also the case with the ten million gallon units.

Two exciter sets have been placed on the main floor just forward of the switchboard platform; the motors furnishing current to the fields of the large pumping motors have an output of 33,000 watts.

Woodwork about the building has been used very sparingly, being confined almost entirely to the window frames and doors. The intake and discharge mains within the building are housed beneath the floor in concrete partitions; the concrete supports for the pumping units elevate the machines ten feet above the lower floor level. A large traveling crane has been installed to facilitate the placing of the huge castings and other parts, also to simplify any future changes or additions that should arise, the crane clears the switch-board platform by nine feet and the platform is eight feet above the main floor level.

LANDSCAPE ART AND CITY DESIGN.*

By Malcolm N. Ross, Park Superintendent, Regina.

The term landscape art in the above connection must be considered in its broadest sense, embracing as it does not only the things usually associated with landscape effects, such as trees and grass, but including all the objects that go to make up the surroundings of a city, for it is only by a clear understanding of the effects of each of these upon all the others that it is possible to arrive at any scheme for improvement in the general attractiveness of a city as a whole.

There is probably no great organized movement so generally in evidence in all civilized parts of the world at the present time as that which has for its object the provision for such conditions and surroundings in our cities and towns as will increase the health and happiness of their people; of course these conditions have always been among the main ideals of life to individuals of all classes, but it is only within recent times that attempts have been made to analyse and specify the things that will produce these results for the benefit of the whole of the people, and to outline the processes by which we may logically expect to be able to permanently ensure them. The important point to keep in mind is that while favored individuals everywhere have been able to secure the fullest enjoyment, the present feeling is that every man, woman and child is entitled to have a share of the good things that are provided by nature.

The surroundings of those who live in the country are naturally healthy, and afford many possibilities for enjoyment to those who have been taught how and where to look for them, the unhealthy and unsatisfying conditions of town surroundings are entirely due to artificial causes that we are only beginning to thoroughly understand, and which can be remedied.

The subject of city design, by means of which we hope to be able to reach our object, is so complex that it is difficult to take a definite line for discussion, and not to be drawn away from it; at present the various branches of work that must be considered in detail in defining schemes for general city improvements are comprised under the term

* Paper read before Arts and Literature Society, Saskatoon, on Jan. 26th, 1912.

"Town Planning." Speaking roughly they include provision for sanitary drainage, means of communication (roads and car lines), suitable buildings, spaces for recreation and the supply of those conveniences such as water and light, which we have come to regard as a matter of course, though occasionally such ideas are rudely dispelled, even in such cities as New York and parts of London.

Unfortunately enthusiasts on certain phases, or often details of city conditions, have taken them up and magnified their importance out of all proportion to the relations they should bear to other phases, and have attempted to force regulations and improvements for one particular purpose only, with the inevitable result that many persons are now inclined to be prejudiced as soon as the term town planning is brought up. I mention this because I find that it is a common practice to talk about "beautifying the city" as if it were something separate and apart from all other branches of municipal progress; something to be tacked on, to conceal or offset the work that must be carried out, and which they think must necessarily be ugly.

My understanding of the matter is this, that the effect on the general appearance of any city depends chiefly on the accuracy and efficiency with which any construction work is done. Not only must the design or plan of the architect or engineer be exactly suited to the work in hand, but the actual workmanship must be equally as good in its way; compare, for example, the general effect of the electric car construction work on Albert Street, where we have carefully designed and accurately placed posts and wires, with the appearance of streets in other cities where crooked and disproportioned wood poles are used, placed at any angle and only in an approximate line; there is nothing beautiful or artistic about the iron poles, but they are correctly designed for the purpose for which they are intended, and can only become annoying by their constant recurrence, which entails monotony.

As a matter of fact, so far as we are influenced by our surroundings, this very point of monotony is probably at the bottom of the situation in the modern town. An object may be perfect in design and composition, but a seemingly endless number of reproductions would soon become offensive, Nothing can be more monotonous than the ordinary long straight roads in our new cities, and all we can say about those in the older cities where they are lined with trees is that they are less monotonous than those along which there are no trees. Contrast and variety are essential in obtaining pleasing results over a large area, and these constitute controlling features in all good modern plans and in practically all of the older cities noted to-day for their attractions apart from historical or other such interests.

Cities always have attracted and will continue to attract people from the country, and they will continue to increase in size, but in order that individual cities may continue to attract and to hold those who come to them they must provide those things that people want, and those cities whose builders can foresee most clearly what these things are and are likely to be, and to make full provision for them, will become the most prosperous and famous as time goes on.

Possibly the best way to determine what these things are is to make a mental survey of the progress of cities in the past and the present to as great an extent as we can, and to follow up the stages through which successful individuals have passed in their search for enjoyment. While not assuming that I have reached a correct conclusion on such a large matter, I venture to say that my impression is, that the desire of the great majority of civilized persons is to secure the greatest amount of personal comfort while at the same time they can surround themselves with the beautiful things provided by nature and art, and the more we examine the lives of men who have become wealthy and so have secured what they desire, the stronger must such a conclusion become, and it seems to hold good in almost all parts of the world, and being so general in so many nationalities I think we may safely accept it as a guide. If we do, then we must decide that the plan on which we must develop our cities is one which will supply the desired comforts and at the same time provide the greatest possibilities for enjoyment to be derived from beautiful surroundings, both artificial and natural.

One of the most significant points in connection with modern town planning is that it is being increasingly guided and developed by landscape architects or in accordance with plans drawn up by them, and the time is almost passed when the engineer or the architect will be employed to design large construction works to be ornamented and relieved at some later date by the landscape designer, for he is now, and will be more in the future, called upon to work conjointly with men of the former profession and his judgment will be considered as having equal, and often controlling, weight, as compared with theirs whenever it is desired to produce the best results, both when individual houses and comprehensive schemes for town development are considered; in fact as far as I am aware practically all the large schemes for remodeling cities in the United States and to a great extent in Europe are in the hands of landscape architects at the present time.

The present rectangular plan of the American and Canadian cities is uneconomical and unsatisfying. However, so far as it exists it must be accepted and methods devised for modifiyng as far as possible its most objectionable features. Almost everyone realizes it. There is sufficient information to hand to enable practical steps to be taken to remedy the objectionable features, and there can be no question that Regina must necessarily take steps to keep up with work of this kind that is being done in practically every city of any importance, and I cannot imagine any more desirable field for investigation and debate than this. In connection with this I should like to read some extracts which seem to me to be peculiarly fitting and accurate and to which considerable weight may be attached, coming as they do from an address made by such a man as Charles W. Elliott, President Emeritus of Harvard University: "I suppose the rectangular lay-out of a city without diagonal or radial avenues is the stupidest thing the American people has done on a large scale and under different natural conditions. Yet to-day city planning must take account of these adverse conditions."

Later on in the same address we find his conclusions as derived from the evidence prepared by counsel for Harvard for the tax commissioners: "The best existing test of the quality of a city or town as a place to live in is the proportion of exempted territory to unexempted. All open spaces such as parks, public gardens, playgrounds, or water areas, schools, colleges, etc., promote the general health of the citizens and give them pleasure." It is not that engineers who have laid out these cities are individually less appreciative of beautiful surroundings than other people, but their training and bent of mind is almost exclusively mechanical and mathematical and their operations are carried out almost entirely according to the standard that at the particular moment is considered to be the most mechanically efficient, and they frequently are unable or else refuse to recognize, that a plan which may be mathematically accurate on paper or when staked off on the ground may produce a composition which will be anything but satisfactory as far as its general appearance is concerned when it is completed and seen in the mass.

The great difficulty here in formulating any plans for improvements is to overcome the opposition of the "practical" man, the man who prides himself that he is above all such petty matters as those which we have been considering; his imagination as far as real estate values are concerned seems to be unlimited, but it all seems to have to run to that line of thought. I suppose the persons who have recently proposed to destroy the boulevard on Victoria Avenue would consider themselves eminently practical individuals, they cannot therefore complain if they are asked to give an answer to the practical question as to what, having proceeded to destroy, for all time, the existing possibilities for a treatment which should make the avenue distinctive and attractive, they would propose to substitute to the people of the city to replace these advantages.

No sane man will pretend that we should spend lavish sums on purely ornamental parks and surroundings while money is urgently needed for such essentials as water and roads, but the danger is that having spent our money on these things and having provided all the means whereby population may be attracted and money made, and having later obtained both, we may then be disappointed to find that there is something missing, and that it is the very thing that we have been unconsciously striving and fighting for all our lives. Is it not time to realize this and to take some active measures to ensure that we and others coming after us will not be so disappointed.

We must get away from the idea that interminable paved streets and concrete sidewalks, accompanied by equally interminable grass strips and rows of trees spaced at equal distances from each and other, varied by an occasional open space in which are a few flowers and shrubs will constitute a satisfactory place to live in, they never can; we must have more originality, variety and change, and get away from the present idea of uniformity in every thing, uniformity becomes only another name for monotony when it is carried out far enough and is used as a very convenient catch word for those who wish to avoid too much work and thought, as it is manifestly more trouble to make plans showing constant variety and change than it is to have one or two stock plans that will with few modifications be applied under all conditions.

Variety will certainly entail a great deal more thought and work and exercise of imagination, but in no other way can we reach a better condition. I particularly emphasize the use of imagination, as it has been the neglect of its use that has brought about the present condition of affairs in most new cities, and it will require the utmost exercise of our imagination if we are going to decide correctly what individual characteristics Regina has or should have and then develop our plans to permanently define these. At present we seem to be simply copying the same system as is being employed in other towns regardless of the peculiar conditions of either Regina or the other places.

England is generally considered to be the country in which the best examples of purely landscape effects are to be found, and there is certainly no other country where landscape gardening has been carried out to so great an extent. But in looking for specific examples of good composition and design we do not find them in the public grounds except to a very limited extent. We are obliged to go to private places, many of which however are open to the public at stated times. The very opposite condition exists in Europe, and although in certain instances we find some of the classic examples of certain schools of landscape architecture owned by private individuals it is to the cities that we must go to see it applied on a large scale. This is probably due to the fact that from one cause and another the educated and wealthy man in Europe has gone to the city to live and in doing so he has demanded to be surrunded by beautiful objects both natural and artificial, harmoniously arranged, and we find public buildings, parks and gardens designed on a general system, which combine to form a beautiful picture in such a way as we are seldom able to find in England.

In the United States we find the improvement of the large cities being taken up in a comprehensive manner, and while there are a few isolated cases where private individuals are going to enormous expense to lay out magnificent grounds and parks it is not thought probable that they will ever be so generally distributed or on such a scale as in England, owing to the uncertainty of ownership due to the absence of any laws of entail; educated people must and will have these things, and the consequence is that most of the cities are now developing large schemes for their general improvement. The result will be that while England must remain the country of beautiful private places, the United States will become the country where the most enjoyable cities for the average man are to be found; in the one case the landscape work is limited mostly to landscape gardening, in the other it is extended to the application of the science and art of landscape architecture over the whole area of public property, and where necessary to the control of private enterprise where it may affect the public interests.

Remarks by Mr. W. R. O. Wynne Roberts, M.Inst. C.E.

Regina may be congratulated, for the persons who had the original laying out of the city, had great foresight in dividing it into residential and commercial sections, providing wide streets, etc. But on the other hand the ideals they then had and some now cherish do not conform with those of the present day. Ideals, like everything human, change with time. When Sir Titus Salt built Saltaire in Yorkshire, the arrangement and conception was highly commended, but to-day they are considered as antiquated and unsatisfactory. When Montreal was in the early stages of development, there was an excellent opportunity for an ideal city, but unfortunately despite the favorable local conditions, Montreal has been built in the usual haphazard way to the regret of its citizens. The destruction which was caused during one of the revolutions in Paris gave Napoleon an opportunity to build the boulevards and provide the magnificent open spaces which make Paris famous among cities. When London was almost burnt about three centuries ago, Sir Christopher Wren advocated building wide avenues, but the opportunity was lost and London is now a depressing mass of bricks and mortar with scarcely a redeeming feature so far as landscape art is concerned. Sixty pears ago the then city engineer of Liverpool recommended the construction of an avenue 180 feet wide and 6½ miles long round the town. It was not adopted, and it is now considered to be an irreparable loss to the city. It will now cost more to widen a 40-feet street to 70 feet for one mile than it would have cost to build the whole avenue.

Those lost opportunities bring in their trail grievous disadvantages. London is willing to spend any amount to rectify the errors of the past. Leeds has now to pay a tax equal to six mills in the dollar to pay for the omissions of the past.

In the West where towns and cities grow with such rapidity there is no excuse for ignoring the lessons to be learnt from the experience of older cities. There is danger that these lessons are not appreciated by the general public, and it may possibly be that in the near future some of our cities will find it necessary to adopt remedial measures.

Take another view of a city expansion. Nature as you all know abhors corners, it is only in crystals we see anything approaching squares and angles. Nature builds up graceful curves, and even the most desolate places can show something of beauty. When man endeavors to carry out some idea it is usually reduced to straight lines, possibly because it is easier, simpler and perhaps cheaper. Mankind nevertheless delights in relief, yet straight lines and squares do not afford it. Streets of houses and villas built to plans of uniformity, even by the most capable architect or engineer fail to impress you. What then will afford relief? Carefully thought out plans of landscape design and a relaxation of the rigid and uniform straight lines and squares will contribute to that end. Encourage the planting of a variety of trees, laying out of boulevards, which will soon be the pride of the city, relieve the flatness of the prairie by sweeping crescents, beautify the open spaces and adorn the avenues with stately buildings.

Winnipeg already finds that laying out of the city is not what it should be, and a commission has been appointed to consider the best way to provide radial and circular roads. I suspect that when Regina grows into the country around, it will be found that the street lines between the suburbs and the central business parts will be too tortuous, and that new avenues will be necessary. Provide these in the early stages o fthe city's expansion and the city will be made more beautiful. It is most desirable. Regulate the buildings, prevent the creation of slums, and encourage everything that will lead to the artistic as well as utilitarian developments of a city.

UNIT COSTS OF REINFORCED CONCRETE FOR INDUSTRIAL BUILDINGS.*

By Chester S. Allen.†

Unit costs are, in a way, like strong drink, harmless where used with judgment and prudence, but likely to bring remorse and anguish where employed promiscuously. Rare and talented, indeed, is the man who possesses the experience, judgment and intuitive sense to know when, where and how to properly modify any tables or statements of unit costs to meet the peculiar conditions of each individual case. While the figures given in this paper are all taken from structures erected during the past two years under the writer's supervision, the wide range of territory, local conditions, and different seasons of the year under which the various pieces of work have been executed is so great as to render the information given of value only in a very general way.

As a general proposition, we have found that reinforced concrete is the lowest priced fireproof material suitable for factory construction, and while it is true that its first cost will generally run from five per cent. to 20 per cent. higher than first-class mill construction, we have recently had several instances where, with lumber at a high price, reinforced concrete has worked out cheaper than brick and timber. It is especially adapted to heavy construction and for heavy loads of 200 pounds per square foot and over where the spans are eighteen to twenty-foot centres not even timber can compete with it.

The unit costs of projected or completed buildings are commonly figured, either as so much per cubic foot or so much per square foot of area occupied. Table I. gives the unit costs, both on the square foot and the cubic foot basis, together with a general description, of a number of reinforced concrete industrial buildings of different types erected during the past two years. It will be seen from an examination of this table that the average cost per square foot of these buildings, excluding the one-story structures, was $1.12, while the average cost per cubic foot was 8.7 cents. The one-story structures both had reinforced concrete sawtooth roofs and the average cost per square foot was $1.77, while 8.5 cents was the average cost per cubic foot. The above costs are for the finished buildings, including plumbing, but do not embody heating, lighting, elevators, sprinklers, and power equipment. The cost per square foot of floor area was obtained by dividing the cost of the building by the total number of square feet of floor area exclusive of roof area, but including basement floors and the cost per cubic foot by dividing the cubical contents into the cost of the structure.

While no coal pockets are included in Table I., it has been our experience that above 3,000 tons capacity reinforced concrete elevator coal pockets cost from $5.50 to $7.50 per ton of capacity. Standpipes, exclusive of the foundations, average from 2½ to 3 cents per gallon of capacity.

On much of the reinforced concrete work which has been done under our supervision it has been possible, owing to the contract being either on a percentage or cost plus a fixed sum basis, for us to obtain quite accurate and comprehensive cost data. This data, of course, is only of particular value where all the local color of each specific case is known, but the average results are at least interesting.

The average unit cost of the 1:2:4 concrete in the floors including the beams, girders, and slabs was $6.10 per cubic yard, and for the columns $6.70 per cubic yard. Where 1:1¼:3 mixture was used for the columns the average cost was $7.60 per cubic yard. This cost was made up of the items of cement, sand, stone or gravel, labor, and plant. The cement, of course, varied greatly with the demand, but the average net cost was $1.35 per barrel including three cents for tests. The sand averaged 80 cents per cubic yard and the crushed stone $1.25 per cubic yard. The cost of labor of unloading the materials and mixing and placing the concrete varied from 65 cents to $2.90 per cubic yard. The cost of plant, consisting of freight, depreciation or rental of mixing and hoisting towers, erection of same, power and coal, and losses and waste on the small tools ranged from 50 cents to $1.50 per cubic yard of concrete placed.

Next to the proper design of the structural features of a concrete building the economical design of the form work is of paramount importance. The truth of this statement is borne out by the fact that on the average job the cost of the forms amounts to about one-third the cost of the entire structure. On the buildings under consideration the average cost of the forms for the floors, including beams, girders, and slabs, was 10 cents per square foot, and for the columns 13 cents per square foot. The lowest cost was in a building of the so-called "mushroom" or flat slab type of construction where, by the intelligent use of corrugated iron for the slab forms, the cost of the floor forms, including

* Presented at the eighth annual convention of the National Association of Cement Users, March 11-16, 1912, Kansas City, Mo.

† Lockwood Greene & Co., Boston, Mass.

wall beams, was 7 cents per square foot, and the highest cost was for an artistic, but not elaborate, overhanging cornice on a 12-story building, which was 32 cents per square foot. This last item rather forcibly demonstrates that any attempt at architectural development is very apt to be a costly proposition.

The cost of the labor of making, erecting and stripping the forms varied according to the price of lumber, design of the structure, method of forming, character of the supervision and the skill of the workmen from 4¾ to 12 cents per square foot. The cost of lumber, nails and oil, divided by the square feet of forms, averaged from 2¼ to 4½ cents per square foot.

The cost of bending and placing the reinforcing steel, including the necessary wire, average $10 per ton, the range being from $5.75 per ton to $17.20 per ton.

Granolithic floor finish 1¼-inch thick, when laid before the concrete below it had set so as to form one homogeneous slab, cost on the average of 4½ cents per square foot. When put on after the rough concrete slab the cost averaged 7 cents per square foot.

Inasmuch as the only economical design of a reinforced concrete structure is one which closely resembles that of the steel skeleton type, the relative cost of the various materials commonly used for curtain walls under the windows, may be of interest. The writer has used brick, vitrified tile, concrete blocks, cast concrete slabs and solid concrete walls for this purpose.

The most common type of curtain wall has been either an 8-inch or 12-inch brick wall resting on the concrete wall beam. The average cost of these walls has been 45 cents per square foot. There is practically no difference in cost between the 8-inch and the 12-inch brick curtain wall, as the saving in material is offset by the great amount of extra labor in culling and laying the thinner wall.

An excellent and inexpensive spandrel wall is constructed by using 8-in. by 12-in. by 18-in. vitrified tile. This is a non-absorbent wall, and when properly laid in cement mortar makes a tight weather-proof curtain wall. The cost of this wall averages about 25 cents per square foot. If the tile is plastered both sides, the cost is about 38 cents per square foot.

Where 8-inch concrete curtain walls were cast in place after the skeleton frame was completed, the average cost was 40 cents per square foot, and when poured simultaneously with the columns 48 cents per square foot. Four-inch cast concrete slabs cost about 35 cents per square foot.

While concrete blocks make a very cheap and light curtain wall, the price being about the same as for the 8-inch tile, the writer's experience with them has been rather unfortunate on account of their extreme porosity.

Where the location of the buildings have demanded special treatment of the exposed surfaces, we have generally specified rubbing with a block of carborundum. The average cost of this work has been 4 cents per square foot. In two instances portions of the structure have been bush hammered with a resulting average cost of 7 cents per square foot.

Concrete piles were used on the foundation of several of the buildings, and the average cost of the piles was $1.15 per linear foot.

The most common methods of waterproofing concrete structures are by the introduction of foreign ingredients into the concrete, by the application of a compound to the concrete surface, by the use of paper or felt waterproofing, and by accurately grading and proportioning the aggregate and the cement.

Where an addition of hydrated lime in the proportions of 10 per cent. to the weight of the cement has been used the added cost to a cubic yard of 1:2:4 concrete has been 50 cents. Patented compounds similar to Hydrolithic cement have cost from 25 to 35 cents per square foot of surface covered. On horizontal or inclined surfaces we have sometimes used a granolithic surface of rich mortar of Portland cement and sand, or Portland cement and screenings in the proportions of 1:1 laid at the same time as the base and troweled as in side walls construction. The cost of this work has been about 5 cents per square foot.

Taken as a whole, the lowest possible cost on a reinforced concrete building can be obtained only by a careful study of each particular case to determine the cheapest type of construction and most economical spacing of columns. As a general proposition, we have found that for light loads with ordinary beam and girder construction the most economical spacing of columns has been 18 feet each way, and for flat slab construction 20 feet each way. For heavy loads, such as 300 pounds per square foot and over, it has been our experience that the cheapest column spacing for beam and girder construction is 15 feet by 15 feet, and for flat slab construction 17 feet by 17 feet. In arriving at the most economical layout it is always well to bear in mind that the construction which allows the greatest simplicity of form units together with the maximum number of repetitions of same is invariably the one that will work out cheapest in the end. The fact that the actual amount of concrete or steel required for a certain floor construction is less than that required in another by no means implies that this is actually the cheapest floor construction, as the unit labor of the form work may easily have been increased out of all proportion

Type of building.	Dimensions.	No. stories.	Story ht.	Live load lbs per sq. ft.
Machine shop ..	120′ x 50′	4	12′ 0″	150
Cotton mill	550′ x 120′	2	16′ 0″	75
		4	12′ 6″	150
Weaving mill ..	140′ x 60′	5	12′ 6″	150
Knitting mill ..	220′ x 75′	2	14′ 0″	125
Factory	223′ x 56′	2	16′ 0″	300 and 1000
Weave shed	341′ x 231′	1		125
Machine shop ..	220′ x 100′	1		
Store house	181′ x 56′	4	14′ 6″	150
Store house	580′ x 109′	10	12′ 0″	250
Store house				
Store house	256′ x 100′	12	8′ 0″	150

Type of construction.	Column spacing.	Total cost per sq. ft.	per cu. ft.
Beam	10′ 0″ x 24′ 0″	$1.17	$0.09
Beam	10′ 8″ x 25′ 0″	.98	0.07
Flat slab	17′ 0″ x 20′ 0″	1.09	0.077
Flat slab	17′ 6″ x 20′ 0″	1.50	0.12
Beam and girder	22′ 0″ x 25′ 0″	1.09	0.073
Beam and girder	18′ 6″ x 18′ 6″	1.55	0.10
Sawtooth skylight	13′ 0″ x 21′ 4″	1.79	0.07
Sawtooth skylight	20′ 0″ x 20′ 0″	1.75	0.10
Flat slab	18′ 0″ x 20′ 0″	1 15	0.07
	19′ 0″		
Beam and girder	19′ 3″ x 25′ 0″	0.85	0.071
		0.76	0.05
Flat slab	16′ 0″ x 16′ 8″	1 04	.12

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ROAD-OILING BY MOTOR-TRUCK.

The motor-truck has evidently come to stay. Its uses are constantly increasing. One of the interesting conditions under which motor-trucks have been used successfully is in the spreading of oil and binder for roads. In a recent report on the macadam roads of Jackson county, Montana, details regarding the methods and costs of treating the macadam roads during the year 1911 are given. The facts recorded are of interest to the municipal and highway engineer as instancing the efficiency to which the motor-truck has arrived. The macadam was thoroughly swept with a rotary street broom hitched to a motor-truck, after which the one side of the road, including the dirt, was oiled and immediately spread with fine grit or dust screenings. After an interval of three days the other side was oiled. In some instances the length of the haul was fifteen miles, the oil being delivered in tanks on side tracks at the railroad station, from which it was pumped into the motor-truck tank. The dust was all hauled by motor also. Oil was applied to over 150 miles of road during the year, having an aggregate area of nearly six and a half million square yards. The actual cost, not including the first cost of the motor-trucks, was about seven-tenths cent per square yard. This cost includes oil, labor, surfacing dust, freight, chauffeurs, repairs to trucks, storage and gasoline for operating. It would appear that the field for the use of motor-trucks is constantly increasing, particularly with regard to municipal operations. No doubt in the future there will be widespread use on road-making, oiling, street-cleaning, and the many other phases of city work.

NORTHERN ONTARIO.

The report on the natural resources and trade prospects of Northern Ontario, issued by the Toronto Board of Trade last week, is another vivid reminder of the pioneering work in Canada yet to be accomplished. There are 20,000,000 acres of good agricultural land to be settled in that region alone. Then we have the Peace River district; the new portions of Manitoba, Ontario and Quebec, given under the recent boundary agreement; large sections of British Columbia and Saskatchewan. When past achievements are considered, they are almost overshadowed by thoughts of the great areas still to be settled and cultivated. This is work for both the present and future generations.

The report on Ontario's Northland presents an idea of the natural resources and of the trade prospects of that country, and it was thought well to quote certain statistics relating to Canada as a whole and others showing Old Ontario's contribution. In this way it is possible to judge what Ontario has accomplished with only the lower portion of the province developed and cultivated. On that basis, and in view of the great natural wealth of the Northland, one is able to realize to some extent the great agricultural and industrial possibilities which exist there and the consequent opportunities for trade.

Emphasis has been placed in the report upon the necessity for the settlement of the land for agricultural purposes. This is done without wishing to minimize the immense importance to Canada of the mining industry. The point which it is desired to make is that to a large degree the business of towns depending for their existence on mining camps must necessarily be to some extent of a temporary nature. On the other hand, those communities backed by extensive agricultural areas, well settled and well tilled, possess a permanent basis.

The principal points of the report may be summarized as follows:—

The railroad mileage, finished and under construction, is sufficient to induce a large agricultural settlement. The outlook for further railroad construction is good. With the completion of the Grand Trunk Pacific and the proposed Canadian Northern Port Arthur to Montreal branch, the railroad steel will run through the northern and the southern borders of the great clay belt, while the Ontario Government railroad connects Toronto and Old Ontario with these developments.

With the continued production of silver in the Cobalt region, there appears to be an opening for a local smelting industry, which would be largely assisted by the adequate water powers in the immediate neighborhood.

The timber wealth of Northern Ontario is the basis of new industrial development. Not only have the total exports of pulp and paper by the United States decreased, but the imports into that country have largely increased, and notably those from Canada. The possibilities of pulp and paper manufacture in the north are such as would seem to demand aggressive action with a view to exploiting the timber resources in that direction.

In view of these considerations, the provincial regulation prohibiting the export of spruce and other woods suitable for pulp, cut on Crown lands, seems amply justified. An analysis of the timber situation in Northern Ontario reveals a need for capital for the development of these resources. Up to the present the capitalists who have interested themselves in this industry have chiefly confined thetir attention to Quebec province. The Northland offers investments equally as good as those of the neighboring province. The desirability of reduced timber dues may be discussed in this connection.

The wooded condition of the large land areas makes adequate fire protection of towns and forest lands imperative.

The available water powers of Northern Ontario are unique, being found among the pine and hardwood forests, and in many cases contiguous to mineral deposits. The raw material and the power for their manufacture are thus side by side. They are the basis of much possible industrial development.

The 20,000,000 acres of agricultural lands offer great inducements to the prospective settler. Land can be taken up within a reasonable distance of railroad facilities and a town. The markets await the produce of the farm-to-be. The land is well timbered, and, while it has to be cleared, offers an unlimited supply of fuel and gives the settler an immediate merchantable asset in the shape of pulpwood.

Considerable assistance is required from the provincial government in cutting roads in the agricultural regions where it is desired to settle. It appears unfair to place almost the entire burden of this work upon the incoming settler himself. Only two government roads cross the last 114 miles of the government railway.

It might prove desirable to consider the appointment of a Northern Ontario colonization commission, whose duty would be to handle the entire question of the agricultural settlement of the Northland. The membership of the commission would naturally include representatives of the various provincial government departments now interested individually in this matter.

The importance of good roads in the Northern bush country cannot be over-estimated. That and similar assistance to the incoming settler is an imperative duty on the part of the Ontario provincial government.

TAR TREATMENT FOR ROADS.

There has been a good deal of discussion among engineers concerning the advantages to be gained by the use of tar as a coating for macadam road surfaces. The consensus of opinion is that tar treatment is justified, although there has been very little evidence from engineers showing the efficiency of the method as to cost.

The City Engineer of Bristol, acting under instructions from the Council, has made an investigation to determine the results of the tar treatment on macadam road surfaces, and has prepared a statement showing the cost of road maintenance each year since the tar spraying was adopted. The report appears in this issue of *The Canadian Engineer*, and shows conclusively that tar treatment under certain conditions is amply justified. On well-laid macadam with light traffic and medium grades excellent results were secured. While little actual saving in cost was shown as a result of the treatment, still the dust nuisance has practically disappeared, and the streets and roads generally are cleaner than ever before. The City Engineer states that there is little question that there has been considerable saving, although it is hard to put it in figures.

EDITORIAL COMMENT.

Toronto's new trunk sewer system will soon be in operation. All that remains to be done is the installation of the pumps at the sewage disposal works and the completion of the high-level intercepting sewer. This will be one step towards the freeing of the water supply of Toronto from contamination and the improvement of Toronto Bay, as the sewage effluent after passing through the disposal works will be discharged into the lake below the city. It is a question, however, whether it will not be necessary to complete the purification by chlorinating the effluent before discharge.

* * * *

There is a bill before the Legislature of Saskatchewan for the protection of persons employed in the construction of buildings. This has been brought in as a result of the many accidents to workmen engaged in the building trades. The bill recites certain regulations which will apply in the erection, alteration, repair, improvement or demolition of any building to prevent accident. The measure authorizes the Lieutenant-Governor-in-Council to appoint inspectors to enforce its enactments in any part of the province. This bill, if carried, will do much towards lessening the accident list in the Province.

* * * *

A peculiar condition of affairs has arisen in New York as a result of an order of the Supreme Court reinstating Mr. James G. Collins as head of New York City Highway Bureau. Mr. Collins was deposed from the Bureau of Highways eight years ago and a successor appointed. Since that time there has been constant litigation between Mr. Collins and the city of New York, with the final judgment of re-instatement with the right to collect salary and interest for the past eight years. The extraordinary feature of the case is that the office of the Bureau of Highways no longer exists, having been abolished a year or so ago, so that Mr. Collins has been reinstated to a position which does not exist.

THE STORAGE OF PORTLAND CEMENT.

Portland cement is easily affected by moisture. It is purposely made so; for, combined with water and other substances, it forms the best of all building materials—everlasting concrete. But moisture must be kept away from cement until it is needed for actual use. This means that cement must be stored in places which are and can be kept absolutely dry. Upon the proper storage of cement are dependent the reputation of the contractor or builder, the trade of the local dealer, and the satisfaction of the user.

Cement on the Work Piled Properly on Wooden Platform.

Temporary Sheds for Contractors and Builders.—On account of the quantity which they keep on hand, dealers and contractors often build special houses for the storage of Portland cement. Almost any material will do for the construction provided it will shed water and will remain weather-proof. Frequently, for temporary storage, contractors build sheds of "up and down" plank covered on the outside with one or more thicknesses of tarred paper. The floor must be above possible high water and open so that the wind can circulate under it. To make the house more completely damp-proof, the floor should be double or its equivalent. Often the same effect is obtained by a makeshift double floor of loose timbers and boards laid upon the regular floor. For such a temporary shed, there is nothing better than a well-made one-way-slope tarred paper roof on sheathing laid with tight joints lengthwise or in clapboard fashion crosswise. Let the roof have a drip or over-hang of at least a foot on all sides. See that it is absolutely water-tight, that the rain cannot beat in under the eaves, and that the roof is fixed so firmly that a wind-storm will not raise it. It is advisable to put no windows in such a house and to have the door so securely hinged and fastened as to keep out intruders. Where use of cement in the work is dependent upon acceptance by test, provision for piling should be made in accordance with instructions given below for dealers.

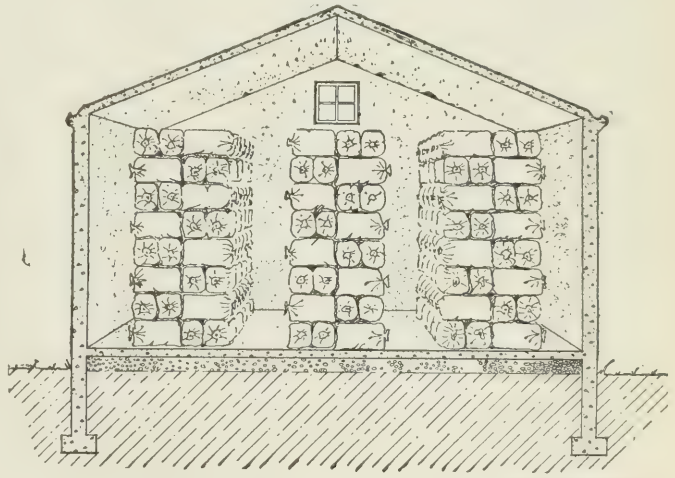
Storage Houses for Dealers.—The same general principles stated above apply to storage houses for dealers. Naturally the house is made more permanent in character. Consequently, it should be supported by a concrete foundation extending into the ground below the frost line. Likewise, for a permanent building, there is no material so good as well-proportioned concrete. Place the concrete floor on sufficient coarse, compacted gravel or broken stone fill to bring the floor level a foot above the surrounding ground. Slope the surface of the floor toward the door. For a one-story building, a 6-inch reinforced wall is strong enough. With a reinforced concrete roof, the cement will be protected from all possible danger of dampness.

Since Portland cement weighs practically 100 pounds per cubic foot, the beams of the floors elevated above ground must be heavy and be supported at frequent intervals by concrete piers. If window openings are necessary, do not use sash. A strong door hinged at the top and capable of being fastened on the inside is much better for keeping out dampness. Often the building has a solid or skeleton lining on the inside, for reasons given under directions for storing cement. It should be well sway-braced on the inside to prevent springing of cracks or bulging.

The size of the house is dependent upon the extent and character of the dealer's trade. An average carload of Portland cement contains about 175 to 200 barrels of four bags each. In determining the necessary size of the cement sheds, consider that each bag of cement stored will occupy one cubic foot. Do not build too small. There is an increasing demand everywhere for Portland cement and the trade of local dealers is far surpassing expectations.

The character of trade has much to do with fixing the size of the storage house. Especially dealers who supply contractors should have sufficient room to keep every shipment separate; for cement used by contractors and builders must often pass a seven or twenty-eight-day test before being used. Moreover, every cement storage house should be large enough to have aisles between the piles of various shipments, so that cement may be removed from storage in the same rotation as it was put in.

Storage for Users of Cement.—Many users of Portland cement need to store it only for the short intervals between the time of hauling it from the dealer and using it in the concrete work. Any building with a good roof, tight sides, walls, and a dry floor will do. Make a temporary double floor by means of small beams or logs and loose boards. See that driving rains or damp air cannot reach the cement.



Cross-Section of Concrete Storage House with Cement Correctly Piled.

Directions for Storing Cement.—Portland cement weight nearly 100 pounds per cubic foot, therefore judgment must be exercised in loading the floor. Likewise, on account of its weight and possible damage from dampness, do not pile

the cement against the sidewalls of the building, unless the house is full-lined or skeleton-lined on the inside. Store the cement so as to leave an open space or an aisle along the side-walls and aisles at places necessary to separate shipments. Get rid of all possibility of the cement piles toppling over by laying the bags, as a mason would say, "headers and stretchers," that is, alternately lengthwise and crosswise, so as to tie the pile together. Examine the building frequently to see that there are no leaks in the roof or side-walls.

Even on the work, never pile cement on the ground or on bricks. Throw down a few blocks, lay boards upon them and make a dry floor for the cement. Have just enough cement on the work to keep things going. A good tarpaulin is handy to cover up the cement in case of a sudden shower. Always buy cement from the dealer who has a dry store-house. If the cement in the bag has been wet, it is hard as a rock: do not use it under any circumstances. However, do not mistake lumps caused by pressure in the store-house for "set-up" cement. Such lumps crumble easily and the cement is perfectly good. Take care of the Portland cement just as carefully after receiving it as a good dealer does, and, properly mixed with sand and stone or gravel, it will yield a binding material proof for all time against fire and repairs.

COST OF ISOLATED PLANT POWER.

The following is a report prepared by the American Engine Company, Pound Brook, N.J., on the cost of isolated plant power, as generated by non-condensing engines with exhaust steam used for heating during the winter season:

Where steam heating is required, electric power may be generated as a by-product of the heating plant, at a cost of less than two cents per kilowatt hour in the majority of cases. The reasons for this low cost of generation may be summarized as follows:

(1) The fixed costs, which go to make up a large share of the cost of power, are chargeable only against the additional investment for the plant by which electric power is generated, over and above the investment for the low pressure steam heating plant.

(2) The coal cost chargeable against electric power is reduced, during those periods when the exhaust steam is used for heating, to a small percentage of the coal consumed, representing that part of the heat in the steam which is lost between the high pressure boiler and the heating system.

(3) The labor charge comprises only the additional labor required, as compared to a low pressure heating plant. Furthermore, by reason of the additional labor, which is of a higher grade, greater economy is obtained in fuel consumption, amounting to a saving in coal of 5 to 15 per cent., which, in a plant of fair size, will pay the wages of an engineer.

(4) While the charge for oil, waste, repairs, and miscellaneous items is incurred entirely through the installation of the engine and generator, they mount up to but a small proportion of the total expense.

Every isolated plant with exhaust steam heating must be considered as a separate problem, because of the wide variation in load, cost of coal, water, labor, etc. The following case, which may be presented as a typical one, will serve to outline the calculation whereby the cost of power may be determined, and secondly, to indicate the influence on the cost per k.w. hour of the three most important factors, i.e., the fixed charges, the price of coal and the amount of exhaust steam used for heating.

Fixed Charges.—An industrial plant operating 3,000 hours per year, with an average load of 200 kw. will be assumed. Two 100-kw. and one 50-kw. engine driven dynamos installed with suitable piping and appurtenances may be set down at $11,000.

Two 200-h.p. boilers would be required. However, the total cost of these boilers would not be chargeable against power since boilers would also be required for the low pressure heating plant. The cost per h.p. of low pressure boilers, grates, stack, etc., is about the same as a similar high pressure equipment. However, as heat is lost and consumed between the high pressure boiler and the heating system, a somewhat greater boiler capacity must be installed when power is to be generated. As the exhaust from an engine contains 80 to 90 per cent. of the heat given it, in the boiler, an increase of boiler capacity of 25 per cent. over the low pressure equipment will easily take care of this item and also any additional cost of a h.p. boiler as compared to a low pressure equipment. Setting down $18.75 per horsepower, including boiler, grates, stack setting, piping and labor of installation, the additional boiler cost is 400 h.p. × 20% × $18.75 = $1,500.

This additional boiler cost will vary, in fact in plants already equipped with low pressure boilers, it will pay to replace the equipment with high pressure boilers and utilize exhaust steam for heating. The effect of thus increasing fixed charges on the boiler plant equipment will be demonstrated in connection with the charts to be presented.

The two largest items of additional first cost, totaling $12,500, have been considered. It might, of course, be profitable to install other apparatus in a plant of this character, as for instance a feed water heater. But as that piece of apparatus should pay for itself out of the coal saved, it will not be considered under the items of additional first cost.

Of the total additional cost of $12,500, a certain fixed percentage must be charged off every year against the cost of power. The fixed charge may be set down as follows:—

Interest at	5%
Depreciation at	5%
Insurance, real estate, upkeep, obsolescence	5%
Total	15%

And 15% of $12,500 = $1,875.00.....(1)

is the fixed charge per year against the additional investment for apparatus to generate power as a bi-product of the heating system.

Labor, Oil, Waste, Miscellaneous.—The cost for additional labor may be taken as one man at $800 per year, while repairs, oil, waste, packing, etc., may be set down as $250, making a total of

$1,050 ..... (2)

Coal.—The coal chargeable against power comprises the coal equivalent of the heat lost between the high pressure boiler and the heating system when the heating season is on, and when no heating is being done, all of the coal burned under the boiler is chargeable against power.

The cost for coal will, therefore, depend upon (a) the steam consumption of the engines per kw. hour; (b) the efficiency of the boiler, or pounds of steam per pound of coal; (c) the cost of coal, and (d) the percentage of the total amount of steam generated which is used by the heating system.

Item (a). The steam consumption of an American-Ball Angle Compound Engine—the engine for isolated plant work—is 26 lbs. per horse power hour (non-condensing), or 40

lbs. per kilowatt hour. In order to be on the safe side and to take care of the effect of reduced and fluctuating loads on steam consumption, assume 60 lbs. of steam per kw. hour.

Item (b). Assume boiler efficiency as 60%, or about 8 lbs. of steam per pound of coal.

Items (c) (d). The cost of coal and the proportion of the total steam generated which is used in the heating system are both variable.

In the table given herewith, the cost of coal ranges from $1 to $5. The amount of steam used in the heating system is taken care of by considering it, as the number of months of the year when the exhaust steam is used for heating. During those months it is assumed that all the exhaust steam is used by the heating system. Strictly speaking, at the beginning and end of the heating season, there are periods when only a moderate amount of heating is required and only a portion of the steam exhausted by the engines is utilized. This decrease in heating load may be taken care of by assuming a shorter heating season. For example, suppose that for four months during the winter, all the exhaust steam was used in the heating season, and that for one and a half months before and after this season the amount of steam used in the heating system varied from zero to full capacity. It would, then, be quite accurate to assume that the heating season of seven months would be equivalent, so far as amount of steam used for heating, to a season of five and a half months, in which the heating load was always equivalent to the full exhaust of the engine.

Water.—An average price for water is 10.0 cents per 1,000 gallons. During the heating season it is assumed that only 80 per cent. of the water is returned to the boiler. During other periods all the water is lost.

It should be noted that it is assumed that in a low pressure heating system all the water is returned to the boiler, that is, there is no loss, and in setting down the additional cost for water when power is produced as a by-product, it is assumed that condensation in high pressure steam piping, condensation in the engine, etc., results in a 20 per cent. loss during the heating season, and when the steam is exhausted to atmosphere, a 100 per cent. loss.

With the fixed costs, labor cost, already given, and calculating the coal and water charges for given conditions, the table and charts shown were obtained. The following example will serve to explain in detail the method of obtaining these figures.

Example.—Assume the heating season equivalent to six months of full load steam heating, during which all the exhaust is used. During this period the coal chargeable against power is the equivalent of the steam and heat lost between the high pressure boiler and the heating system. Assume that 20 per cent. of the heat of the steam is lost in this manner. The other factors entering into the coal cost have already been given, i.e., load 200 kw., steam consumption 60 lbs. of steam per kw. hour, coal consumption 1 lb. of coal per 8 lbs. of steam, hours per year, 3,000. With coal at $4.00, we then have the cost for coal during the 6 months heating period, as follows:

$$\frac{200}{2} \times \frac{3{,}000}{8} \times \frac{60 \times 20\% \times \$4.00}{2{,}000} = \$900.$$

The part of the year when there is no exhaust steam heating, and those parts of the year when only part of the exhaust steam is used for heating, are equivalent to six months of straight non-condensing operation. The cost of coal is therefore:

$$\frac{200}{2} \times \frac{3{,}000}{8} \times \frac{60 \times \$4.00}{2{,}000} = \$4{,}500.00.$$

To this coal cost must be added the cost for water which may be set down at 10 cents per thousand gallons. During the heating season the heating system returns 80% of the boiler feed. The cost for water is then:

$$\frac{200}{2} \times \frac{3{,}000}{8.33} \times \frac{60 \times 20\% \times 10¢}{1{,}000} = \$43.20.$$

Table I.

Cost of power per kw. hour in a typical isolated plant. Average load 200 kw.:

Months of Exhaust Steam Heating.	Price of Coal $ Per Ton.					
	$0	$1	$2	$3	$4	$5
2	.550	.880	1.200	1.525	1.850	2.175
4	.540	.820	1.090	1.365	1.640	1.915
6	.531	.755	.983	1.205	1.431	1.656
8	.521	.700	.871	1.046	1.221	1.396

For the other six months the cost for water is as follows:

$$\frac{200}{2} \times \frac{3{,}000}{8.33} \times \frac{60 \times 10¢}{1{,}000} = \$216.00.$$

We may now set down the total charges for generating power at the rate of 200 kw. for 3,000 hours a year, as follows:

Fixed charge	$1,875.00
Labor, oil and miscellaneous	1,050.00
Coal	4,500.00
	900.00
Water	216.00
	43.00
Total	$8,584.00

During the year there are developed 3,000 × 200 = 600,000 kw. hours, giving a cost per kw. hour of

$8,584 ÷ 500,000 = 1.431 cents per kw. hour.

In the same manner it is found that when heating season is equivalent to only two months of full-load heating the cost per kw. hour is 1.85 cent. For the same conditions when the price of coal is $5.00 instead of $4.00, the cost per kw. hour is 2.175, and in this way the table shown was compiled.

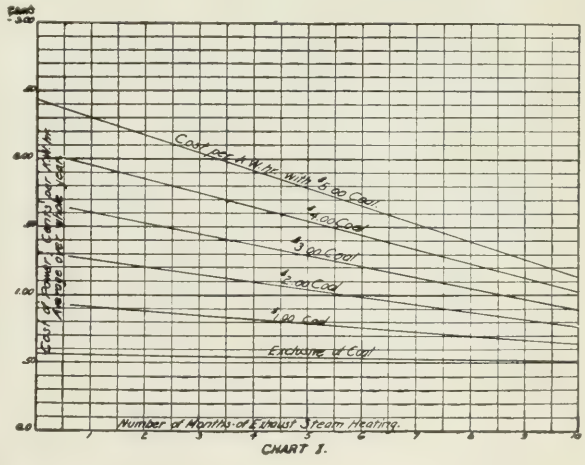
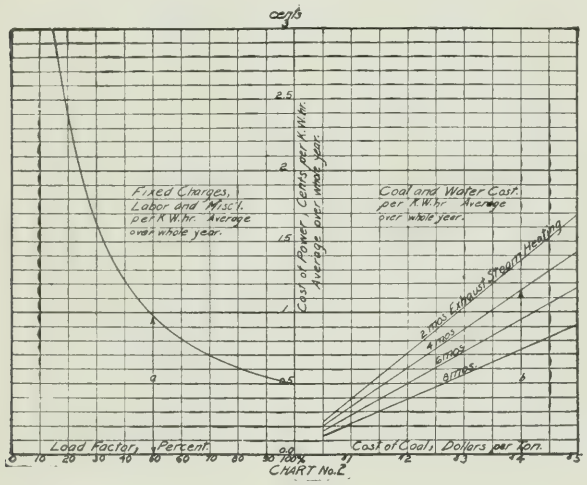


CHART 1.

Charts.—From this data the charts of Figure 1 and Figure 2 were prepared. In Figure 1 the cost of power in cents per kw. hour (average over the whole year) is plotted against the number of months that exhaust steam is used for heating, each line represents a different price of coal. With this chart in hand, we can study the influence of coal

cost, length of heating periods and also the influence of first cost, and also of percentage of that cost which should be charged off per year, in order to take care of interest, depreciation, etc.

Suppose, for instance, as has already been suggested, that instead of considering the additional cost of a high pressure boiler plant, and engine, as against a low pressure boiler plant, we desire to find out the cost of power in a plant where a low pressure boiler is already installed and must be replaced. The additional first cost of the high pressure boiler over and above the low pressure boiler taking into account the fact that a boiler of higher capacity would be required, was set down in the foregoing analysis at $1,500. Assume that an entire new boiler would be needed, costing five times this amount, or $7,500. This would increase the additional first cost of the plant by $6,000 and the additional yearly charges by 15 per cent. of $6,000, or $900, making the total fixed charge $2,775, instead of $1,875, and for 600,000 kw. hours per year, would increase the fixed charge per kw. hour from .312 cents to .462 cents, or an increase of .150 cents. The influence of this additional charge of .150 cents upon the cost of power with $4 coal, and when three months' exhaust steam heating is used, is therefore an increase from 1.75 cents to 1.90 cents per kw. hour.


Fixed Charges, Labor and Misc'l. per K.W.hr. Average over whole year.
Coal and Water Cost per K.W.hr. Average over whole year.
Average Cost of Power per K.W.hr. Cents
Load Factor, Percent.
Cost of Coal, Dollars per Ton.
CHART No. 2

In the chart of Fig. 2 the cost per kw. hour is plotted against the cost of coal in dollars per ton, and each line represents the cost for different lengths of heating periods. This chart is useful for investigating the effect of the price of coal and also the comparative effect of length of heating season and price of coal. For instance, the cost per kw. hour is practically the same for an eight months solid heating season with $4 coal, as it is with a two months heating season with $2 coal.

On reference to this chart it will be noted that the cost exclusive of coal and water are considered separately, being plotted against load factor.

A load of 200 kw. 3,000 hours per year is considered as 100% load factor (although the plant capacity is 250 kw.). At 100% the fixed charge, labor charge, etc., per kw. hour is $\frac{\$1,875 + \$1,050}{600,000} = .488$ cents. Similarly at 50% load factor the cost per kw. hour, exclusive of coal and water, is $\frac{1,875 + 1,050}{300,000} = .976$ cents.

By similar calculations the complete curve is plotted, which may be used in connection with the curves at the right in order to study the cost of power under various conditions. Suppose, for instance, that the load factor is 50%, then the ordinate "a" = 98 cents = fixed charge, labor, etc.; if the coal cost is $4 a ton and the number of months exhaust steam heating is 4; then the coal and water cost per kw. hour is given by "b" which equals 1.17 cents and the total cost of power per kw. hour equals a + b = 2.15 cents.

Now, the question that naturally arises in the mind of the consumer of electric current is this:

If the isolated plant with its small capacity and efficiency, further decreased by the fact that it must exhaust its steam for a part of the year to atmosphere, can generate power for two cents a kw. hour, why is it that the central station, in which maximum economy is obtained by cutting down all losses, generating in large units, operating, condensing, etc., cannot generate power at a far less cost than this and sell it for a price approximating one to two cents per kw. hour?

The central station can produce power **at its own switchboard** for a cost including both operating and fixed charges of one cent per kw. hour. But this is only a part of the total cost to the consumer, since it is necessary to have an elaborate and expensive transmission and distributing system of copper cable, feeders, sub-stations, etc., in order to deliver the power. The power house furnishes electricity to the distributing system, which acts as a carrier, and which must pay interest, depreciation, franchise and maintenance charges, just as must a railroad. As with the railroad, there is a natural tendency towards rate discrimination, and it is only the favored consumer who obtains power at a reasonable charge, while the other man bears the burden.

COMING EFFICIENCY IN WATERWORKS MANAGEMENT.*

By W. H. Richards.

Much has been written of late of scientific efficiency, the aim being to get a greater return with less effort, but behind this movement is the increasing desire to promote that efficiency which saves material as well as labor and thus reduces cost of output. So strongly has this idea taken hold of the people that the day is not far distant when the management of at least all the larger corporations, both public and private, will be judged by the resulting cost.

So far as water departments, either public or private, are concerned, this will first manifest itself in the cities of medium size. And it is important that this society conside. some of the ways in which this demand must be met, and it is with this in view that this paper is presented.

Whatever of criticism will be found in this paper applies with equal force to private companies or public corporations, as lack of efficient management is found as often in one as in the other, and in the final analysis the public pays in each case.

To promote the greatest efficiency the board of managers or commission, by whatever name it may be called, should be non-political and its duties should be strictly separated from the executive part of the work, being confined to matters of general policy, approval of expenditures, appropriations, general plans, formulation of rules, etc., appointment and removal of subordinates being made only on recommendation of the general manager, superintendent, engineer, commissioner or whatever title may be given to the executive head, for upon the latter rests, or should rest, mainly the responsibility for the efficiency of the work. For the

* Paper read before the New England Water Works Association and printed in the Journal of the Association.

remainder of this paper he will be referred to as the superintendent.

What kind of a man should the superintendent be? Not necessarily an engineer in the sense of being a graduate with a "sheepskin," but he certainly should be an engineer in the larger sense that he should be ingenious, capable of interpreting a drawing or making one if necessary, with a thorough knowledge of construction and tools, and he must have or immediately acquire a knowledge of the fundamental principles of hydraulics, and over and above all else he should understand the principles of business management. Such a man, it is perhaps unnecessary to state, cannot be secured for $1,200 or $1,500 per year. If the organization be a new one, several years must elapse in experiments, and usually the "fads and fancies" of the superintendent have to be tried out and their utility tested. Even with the above qualifications he has much to learn, for the management of waterworks requires much special knowledge.

The powers of the superintendent should be large, and to secure the greatest efficiency he should have a voice in the appointment of his subordinates, as well as the power to recommend discharge after proper hearing, for efficiency cannot be secured without discipline by a single responsible head. With such an organization the economy in conducting the work will be improved from year to year; efficiency without economy is impossible. Many policies have been settled by experience, and most of them have been put in print, but there remains much that is experimental, and the solution of many problems must be left to the ingenuity of the superintendent as they arise. For instance, while the efficiency of the cast-iron mains has been pretty thoroughly tested with most waters, the life and coatings of steel mains are still problematical. The size of mains necessary in certain places offers a wide field for ingenuity and thought on the part of the superintendent; so with the service pipe; except in special qualities of water, lead is almost universally used, yet the regulation of the size is subject to wide variation dependent on the pressure and quantity of water necessary or desirable to be supplied in a given time, and the regulation of the size calls for even more consideration than the size of the mains, for the theory that a certain quantity of water will go through a certain-sized hole regardless of the length of the pipe is one of the most common errors of the ignorant and unthinking.

I believe no one has yet discovered the best water meter, yet there is a chance to exercise considerable judgment of the kind or type for different circumstances or uses, and if the board of management insist on selecting the cheapest without regard to material or construction, the result will be disastrous to the efficiency of the meter department.

The conclusions of sanitary experts are changing every minute, and the superintendent must have a very logical mind to separate the theoretical from the practical.

What about the composition of the board of directors? The corner grocery or professional politics do not usually fit men for undertaking large affairs, and a man who never handled a hundred dollars in his life is somewhat bewildered when given $100,000 to spend. Some men are so constituted that they magnify a dollar to cartwheel size; others have so little knowledge of its value, especially when it belongs to some one else, as to ignore its size altogether. The first, while saving cents, will lose dollars, and the second will lose both. The best proof of a man's ability to manage large undertakings for other people is that he has managed his own large business successfully. A board of managers, for instance, when buying land or rights, may in their effort to drive a sharp bargain, overreach and get into a law suit which will cost many times the amount saved. Another board may saddle the city or company with a filter or an expensive reservoir unnecessary for the time being at least.

In construction or extension of the work where it is necessary to engage a designing engineer, the superintendent may give advice which should always be given consideration. For the design of work is one thing and the care of it another. Many a superintendent has been worried into the grave trying to adapt an impractical scheme designed by an engineer without experience in management.

The board, when selecting its designing or consulting engineer, might remember that a six weeks' trip to Europe does not make an engineer, and might well consider if an expensive filter or massive dam is necessary. The interest account of many a city or company is burdened with the cost of an extravagant structure built but to gratify the fad of the designing engineer.

A celebrated foreign engineer, on viewing a large waterworks dam, once said that "any fool could build a dam if he could use a large enough factor of safety."

It should be borne in mind that every gallon of water has a fixed value, and that that value is dependent on the cost and capacity of the work and the expense of maintaining it. No work can be run efficiently until this fact is recognized and understood. If the rates are so regulated that one man gets two gallons for the price of one, then the man who uses one gallon and pays for it pays part of the other man's water rate.

The cost of the water system and its maintenance should be borne by the consumer of water and, except as to that part of the expenditure necessary for the extinguishment of fires, in proportion to the amount of water used.

The practice of furnishing water free to the city departments, hospital and other institutions which may make a plausible plea to the board, as well as the practice of furnishing extra fire protection free to certain parties who are patrons of certain insurance companies, is not only unjust to the ratepayers, but makes a statement of the measure of efficiency impossible.

If it is thought necessary to lay out a park or pleasure ground on lands controlled by a public water department, why not charge it to the park department? What has tree culture to do with the conduct of a water system?

Many cities have tons of lead service pipe where they will never be used, laid with the expectation of preventing the disturbance of the pavement which other public service corporations dig up without hindrance. It has become necessary in one large city to expose the mains and shut off these unused extra service pipes to prevent leakage.

Few water departments make any account of water furnished to other city departments, and, on the other hand, few water departments make remuneration for damage to streets. A precise system of accounting would stop many leaks in a waterworks system. In fact, it is usually impossible to tell whether the works are efficiently managed or not from the published accounts. A balance sheet is of rare occurrence in a water report, and an inventory or any charge for depreciation still more rare.

The president of one water company furnishes all water pipe used, and a relative furnishes all coal, without competition; the water taker pays for both, in high rates. The superintendent has been dismissed, being of a too prying disposition. Another water company has all outside work done by a relative of the president on a percentage. What is more common than for one member of the board to interfere with details of the management of a department?—and the more ignorant he is the more likely he is to interfere.

Of what use is a meter system when 30 per cent. of the water is wasted by poorly jointed pipe and 20 per cent. by the waste in public buildings?

Efficiency can only be effected by order and system coming through one responsible head, and that head must be more or less of an autocrat, each subordinate being in turn responsible to the one above.

In this age, when improvements in methods and means of transacting business are constantly being introduced, it requires constant study and clear discernment to find and apply the device or method necessary for the particular work.

In a city of considerable size it is impossible for the superintendent to observe every detail of the work, and he will accomplish more in his office than in his automobile, but he must first acquire a knowledge of the work and his subordinates by observation. At his desk he decides a multitude of problems, from the color of paint to quality of yarning, from the probable registry of an obstructed meter to the efficiency of his pumps; and all the time he must know what each subordinate is doing and what he is going to do the next day.

This in general is an outline of some of the things necessary to have and a few of the things to avoid in an efficient waterworks system, and the efficiency is measured by the cost of the water supplied, taking into consideration its quantity and the necessary expense to secure and distribute it.

As mentioned above, the time is fast approaching when the constantly increasing indebtedness of water supply systems will attract the public attention and managers will be held strictly accountable to the public. Until that time comes, the following description of the waterworks superintendent by President Alvord, of the American Water Works Association, will hold good: "He has held out to him no alluring pension as a reward for the honest, faithful and nerve-racking care and service he gives, but is haunted day and night by fear of a broken main, failure of water supply, or of disease tracable to the water. He has trouble securing funds for procuring the necessary equipment, and, above all, has to deal, always courteously but firmly, with the ever-present infuriated citizen who insists he is not getting his just dues from a government he helps to support."

How can efficiency be best promoted? I should say by system carefully thought out, by having order everywhere, and by well-defined rules thoroughly and impartially enforced.

COMBUSTION OF PULVERIZED COAL.

In a paper read before the American Institute of Chemical Engineers, L. S. Hughes summarized the advantages of using pulverized coal and discussed the difficulties encountered in its use. The chief difficulty has been the destruction of the firebox and crown-sheet. Both bricks and steel "melted" little by little, which effect has been attributed to the high temperature of the flame produced by pulverized coal.

When the temperature of the flame was reduced, the grate bars, crown-sheet and walls of the firebox became covered with a vitreous, adherent coating of slag or clinker. This clinker is similar to the slag produced in blast furnaces and is evidently formed by the action of the silica of the ash with iron oxide forming a complex fusible silicate. The silica would also act on the firebrick by reducing its melting point.

The remedy suggested and tried consisted in introducing powdered limestone with the coal dust. A simple air-blast injector fed the coal into the firebox and a small amount of limestone, roughly equal in weight to the ash of the coal, was introduced with it. Immediately the character of the ash formed changed from a sticky shower to a dry, pulverulent dust which displayed no tendency to cohere or clinker in any way.

ONTARIO'S MINERAL PRODUCTION.

The total value of the mineral production in Ontario, as shown by the figures appended, was $41,432,898, an increase of $2,119,003, or 5.38 per cent., as compared with 1910, when the output had a value of $39,313,895, or an advance of 25.62 per cent. over the production of 1909, which was $32,981,375. There are seven mineral products that each had a value of one million dollars or over during 1911. Of these which show an increase in value of output over that of 1910 are silver, pig iron, common brick, Portland cement and natural gas. Nickel and copper show a decrease.

In compiling statistics of value, the basis adopted by the Ontario Bureau of Mines is the value of the several products in the form produced, and at the point of production. Were the methods of computation employed by the Department of Mines of Canada, or some of the other provinces, adopted, Ontario's mineral output would be shown to have a considerably higher value.

Metallic.		Quantity.	Value.
Gold	oz.	2,153	$ 42,638
Silver	"	31,507,791	15,949,019
Cobalt in crude Cobalt material.	lbs.	432,749	58,687
Cobalt oxide, Cobalt-nickel oxide, etc.	"	111,823	112,203
Nickel	tons	17,049	3,664,474
Copper	"	8,966	1,281,118
Iron ore	"	175,631	445,930
Pig iron	"	526,610	7,716,314
			29,270,383
Less Ontario iron ore (67,631 tons) smelted into pig iron			172,391
			29,097,992
Non-Metallic.			
Arsenic	lbs.	4,341,078	74,609
Brick, common	No.	316,000,092	2,480,177
Tile, drain	"	21,461,000	343,956
Brick, pressed, etc.	"	51,843,548	562,345
" paving	"	4,522,400	86,658
Building and crushed stone			882,667
Calcium carbide	tons	1,383	84,437
Cement, Portland	bbls.	2,943,003	3,563,995
Corundum	tons	1,471	147,158
Feldspar	"	17,697	51,610
Fluorspar	"	30	200
Graphite	"	894	36,492
Gypsum	"	20,335	32,535
Iron pyrites	"	43,629	118,457
Lime	bush.	2,335,085	394,551
Mica	tons	322	43,058
Natural gas			2,068,429
Peat	tons	1,180	2,830
Petroleum	Imp. gals.	10,102,081	353,573
Phosphate	tons	20	240
Pottery			50,500
Quartz	tons	56,723	64,405
Salt	"	88,689	430,835
Sewer pipe			410,064
Talc	tons	7,104	51,125
Total non-metallic production			12,334,906
Add net metallic production			29,097,992
Total production			$41,432,898

The greater part of the production came from Porcupine, being derived from the small test mills at two or three properties. The fire destroyed these mills and thus caused the output to be smaller than it otherwise would have been. The two or three large mills that were in course of construction were also destroyed. The new mills at the Dome and

Hollinger mines are nearing completion and will be in operation about the end of the first quarter of the year. The branch of the Ontario Government railway, the Temiskaming and Northern Ontario, is now in operation to South Porcupine, and is almost completed to the townsite of Timmins. The plant of the Canadian Exploration Company at Long Lake, near the Sault branch of the Canadian Pacific Railway, is nearly completed. As soon as electric power is available the mill will begin operations. Toward the end of the year, the St. Anthony mine at Sturgeon Lake, northwest of Port Arthur, was unwatered, and milling of ore has begun. The Belmont or Cordova mine, in Hastings County, has, after being idle a number of years, begun operations under new owners. There was a small production of gold from seven or eight mines, in addition to those mentioned, in other parts of Northern and Northwestern Ontario.

The entire production came from the mines of Cobalt and surrounding region. The output in 1911 was 31,507,791 ounces, this being the greatest annual production since the beginning of mining at Cobalt, exceeding the production of 1910 by approximately one million ounces. The shipments of bullion from Cobalt increased greatly during the past year, owing chiefly to the operations of the refinery of the Nipissing mine. The process employed by that company is somewhat unique, being a combination of amalgamation and cyanidation. There was a shortage of power during the early part of the year owing to an accident to one of the large plants. The power situation has since been satisfactory. The extension of the concentration process has brought about a change in the character of the shipments. Instead of much low grade ore being shipped from Cobatl, the shipments now embrace a large quantity of high grade concentrates. That silver is produced at a very low cost at Cobalt is shown by the last annual report of one of the companies, the Coniagas, which produced metal throughout the year at an average total cost of 8.8 cents an ounce, including mining, concentrating, freight to smelter, sampling, assaying, and treatment charges and all head office expenses and royalties.

At Cobalt in 1911 there were seven mines which each produced 1,500,000 ounces or more of silver. In order of production they are as follows: Nipissing, 4,627,043; La Rose, 4.090,157; Crown Reserve, 3,430,902; Coniagas, 3,273,464; McKinley-Darragh, 2,551,884; Kerr Lake, 2,238,353; Buffalo, 1,644,245. Three other mines produced over a million ounces each.

Two properties at Gowganda were producers during the year, as were also two in South Lorrain.

Refineries at Copper Cliff, Deloro, Thorold and Orillia continue to treat the greater proportion of the high grade ore shipped from Cobalt.

The dividends paid by the companies operating at Cobalt and in South Lorrain in 1911 amounted to $8,588,916, or over one-half of the total value of the silver produced. The total dividends distributed up to the end of 1911 amounted to $30,391,095, not including profits made by two or three privately owned mines or close corporations. For the whole period since the mines were opened at Cobalt, there has been produced from this part of Ontario 125,571,980 ounces of silver, which brought the mine owners $64,317,352.

The quantity of cobalt in crude material shown in the table is only that part of the output which mining companies were paid by purchasers of ore. A much larger quantity was shipped out, but, for the most part, brought no returns. The table also shows the quantity and value of cobalt oxide, cobalt nickel oxides, and other cobalt-holding material shipped by the refineries of the Province. The market for cobalt oxide continues depressed.

The nickel mines and smelters in the vicinity of Sudbury had a smaller output in 1911 than in 1910. Toward the end of the year, however, the output was increased, and the two operating companies are preparing to still further increase it. The Mond Nickel Company is arranging for the erection of a plant with increased capacity at Coniston, east of Sudbury, at the junction of the Canadian Northern with the Canadian Pacific Railway.

The nickel contents of the silver-cobalt ores, which yield nothing to the mine owners, are not here included in the output of nickel.

The copper produced in Ontario last year came from the nickel-copper mines at Sudbury. The two metals, copper and nickel, occurring together, the output of the former rises and falls with that of the latter. In 1910 the production of copper was 9,630 tons, in matte. In 1911 it was 8,966 tons. The price of the copper in the table of statistics, like that of the nickel, is based on its value in the matte and not on its refined value.

In 1911, all the hematite shipped came from the Helen mine of the Lake Superior Power Company. The quantity was 137,377 tons, an increase over the shipments of 1910, which amounted to 112,246 tons. Three other mines shipped a total of 38,254 tons of magnetite.

The 526,610 tons of pig iron produced came from the following companies, viz., Hamilton Steel and Iron Company, Atikokan Iron Company, Standard Chemical Company, Canada Iron Corporation, and the Algoma Steel Company. The Hamilton Steel and Iron Company were also producers of steel. Of the ore smelted, 67,631 tons were of domestic and 848,814 of foreign origin.

Discoveries of metals, not hitherto found in economic quantities in the province, include mercury and tungsten. The former metal occurs in the silver-bearing Cobalt ores, and the latter in the mineral scheelite, in certain gold-bearing quartz veins at Porcupine.

The value of the building materials, such as brick and Portland cement, produced in 1911 shows a material increase over that of 1910. There is an increasing demand for suitable stone for road-making, and arrangements are being made for opening quarries to supply the needs of the older part of the province. Marble from the quarries near Bancroft, in Hastings County, is being employed for the decoration of the interior of buildings.

The production of petroleum continues to decline. The output during 1911 amounted to 10,102,081 Imperial gallons, as compared with 11,004,357 in 1910.

In contrast to petroleum, natural gas shows an increased production year by year. In 1911 natural gas from Ontario wells had a value of $2,068,429, while in 1910 its value was $1,490,334, and in 1909 considerably less, $1,188,179.

By counties, the new producing wells of 1911 are distributed as follows, viz., Welland 26, Haldimand 124, Brant 60, Norfolk 19, Wentworth 9, and Elgin 16.

Among the products of lesser value, calcium carbide shows a decrease in 1911 as compared with the preceding year. This is due to the absorption of Ontario plants by an extra-provincial company and the closing or partial closing down of the works during a part of the year. Talc shows a considerable increase in quantity and value of output, as does iron pyrites. Another acid plant, which will use pyrites as a raw material, was erected in the province during 1911. There are a number of industries which, owing to abundance of raw material, are capable of great expansion. These include gypsum and salt, both of which show an increased output during the past year.

Ontario's mineral industry is characterized by the variety and uniqueness of its products. Moreover, it is characterized by rapid increase in the value of annual output during recent years, and it offers great scope for increase in the future.

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SEWAGE SLUDGE.

A Review by T. Aird Murray, M. Can. Soc. C.E.

"Sewage Sludge" is the title given to a volume publish- by the McGraw-Hill Book Co., of New York, (price .50.) The volume is divided into four parts, viz., "Treat- ent and Utilization of Sludge," by Alexander Elsner; The Drying of Sludge," by Dr. Mg. Fr. Spillner, Essen- uhr; "Results of the Operation of Some of the Mechanical wage Clarification Plants of the Emscher Association," Dr. Mg. F. Spillner and Mr. Blunk; and "Sludge Treat- ent in the United States," by Kenneth Allen, M. Am. oc. C.E.

The first two parts are translated from the German by enneth and Rose S. Allen, while the third part is trans- ed by Emil Kuichling, M. Am. Soc. C.E.

The four parts of the volume, although distinct and mplete treatises in themselves, offer a combination and ity of comprehensive treatment which has not hitherto en attempted in connection with this special subject from e standpoint of actual results in practice, experimental ta and general observation.

To the engineer, the practical and efficient dealing with e sludge question has now assumed greater importance an hitherto. The general crystallization of the important ws and features, both chemical and biographical, in con- ction with the removal of putrescibility from sewage, has ade itself more apparent of late. Apart from the academic rries which scintillate about some of the more abstruse d impish problems and doctrines affecting the why and e wherefore of certain effects, the ordinary sanitary en- neer, who is not constituted as a sort of chemical intro- ective Hamlet, weighed down by indecision, feels that he n design some sort of a sedimentation tank which will ep back a goodly proportion of the suspended solids, as ell as some sort of a continuous filter which may last a nsiderable period without choking, and so turn out some rt of an oxidized sewage effluent which will not do much arm. But, all this done, there are yet these suspended lids, no longer suspended perhaps, but slightly more con- ntrated and waiting patiently at the base of the tank ask- g the question, "Now, what are you going to do with e?"

It is no longer possible for the engineer to simply say, Oh! I have designed a septic tank. If you will only not ouble the solids, they won't trouble you. These solids re- ain, accumulate, and with their awkward mixture of any- ing from 75 to 95 per cent. of water, have to be eliminated omewhere and somehow, with the least possible odor, fly other nuisance. They have got to be disposed of, rendered offensive, dried, buried by land or sea, burnt, in fact ther naturally or artificially, as sewage solids, annihilated.

Our English contemporary "The Surveyor" recently tated: "The solution of the sludge problem is the most ressing question of the day, and a little practical assist- nce in this direction from our scientists would be of much reater value than all the learned dissertations in theories nd doctrines with which we have been favored in recent years." The sludge question, like the poor, we have al- ways with us. The proof that the subject is of no mean importance is found in the numerous schemes, both natural and mechanical, which have been tried, suggested and ex- perimented with for the one purpose of changing this slimy, viscous, greasy, useless semi-liquid, with something of a more wholesome, or more useful character.

The first three portions of the volume under discussion will be of considerable interest and practical use to en- gineers, as they deal principally very fully with the practical and experimental work in Germany, both with reference to the final disposal of sludge, the reduction of its water con- tent, by pressing, incineration, exposure, and centrifugal appliances. The fourth portion is also of interest from the American point of view, although the author is very much handicapped in the fact that little or no attention has as yet been given to the practical dealing with sludge by me- chanical methods in the States.

The introduction of the centrifuge, after the principle of the cream separator, is of German origin, and efficiencies in results and cost operation are given and compared with other methods, such as pressing. Germany is the banner country of scientific domestic economy, and the whole ques- tion of the utilization of sludge or its products for purposes of fertilization is fully dealt with. Generally speaking, this is the saddest chapter in the story, as in almost every case, the adoption of very expensive methods to make sludge as attractive a soil manure as possible, have resulted in practically bribing farmers to use it after it has been simply thrown at them. The attempts to extract what was once valuable grease from the sludge have, generally, only resur- rected a sort of a ghostly grease with a foul smell which no decent grease should have.

Quoting from page 125, we have the sad experience of Cassel in Germany, "at a cost of $47,600 a reduction plant was built where grease was recovered by the use of benzine after most of the water had been removed by filter presses, and the residue was used as a fertilizer. From 65 cu. yds. of wet sludge 6½ cu. yds. of dry sludge was expected, from which 1,650 lbs. of crude grease and 10,750 lbs. of fertiliz- ing sludge was looked for. The latter was estimated at 32½ cents per 100 lbs. to be worth $34.88. From the crude grease 990 lbs. refined grease was realized, which was estimated at $4.87 per 100 lbs., to be worth $48.20, and 495 lbs. of tarry residue which was estimated at 41.6 cents per 100 lbs. The total revenue from 65 cu. yds. of wet sludge was, therefore, estimated at $88.14. In spite of this, the expenses were greater than the receipts, and the plant was abandoned and taken down. One reason for the failure, aside from the high cost of drying, was that the grease obtained was not marketable, on account of its disagreeable odor."

Apart from any wish to depreciate the value and pos- sible good results which may yet attend the utilization of products derived from sewage sludge and lead to economy in methods of effective disposal, such examples of failure are of obvious value to Canadian engineers, who are, in many cases, approaching a comparatively speaking new en- gineering issue, as far as this country is concerned.

In the future, just as it has been in Great Britain and European countries in the past, many very exaggerated opinions will be held as to the possible values of sewage with reference to its fertilizing and other attributes. It behoves the municipal engineer to prepare himself with what data there exists of value upon this subject. It is not only a question of utilization of by-products, but the much more important question of so disposing of the retained suspended solids of sewage in a clean and efficient manner to meet both the æsthetic and the hygienic requirements of a neighborhood.

The volume under consideration is certain to become a standard for reference and most certainly meets a demand at the psychological moment of requirement. The student will find the whole subject carefully and fully dealt with. The problem of incineration and its many difficulties, owing to the low calorific value of sludge and the presence of water; the difficulties to be met with in pressing sludge without the admixture of chemicals, the comparative qualities of various sludges as presented by ordinary sedimentation tanks, septic tanks and the newer forms of tanks which allow of separate sludge digestion. Perhaps not the least interesting and valuable data presented is that appertaining to clarification of sewage in the Emscher district in Germany.

BOOK REVIEWS.

The Corrosion of Iron and Steel. By J. Newton Friend. Published by Longmans, Green & Co., London; 290 pages; price $1.80.

It can be safely said that no subject is of more practical importance than that dealing with the corrosion of iron and steel. It is a subject that has engrossed the attention of numerous investigators, with the result that many theories as to the cause of corrosion have been advanced. Within recent years, though, the results of practical tests under actual service conditions have been given their due amont of weight, so that a reasonable agreement seems to have been reached in the various theories. There is one obstacle, however, that confronts the new investigator at the present time, namely, that a great deal of previous work has been very loosely recorded, if, indeed, any record of it has ever been made. In his treatise Dr. Friend has made an attempt to gather together the data of research carried on up to the present. The work is not purely historical, however. A great deal of very practical information is distributed throughout the book.

The practical standpoint of the book is indicated in the discussion on the value of the so-called acceleration test. It is clearly pointed out that this test, leaving out of account as it does many of the factors that enter into the commercial problem, is by no means a true criterion of the relative values of iron and steel in resisting corrosion.

Beginning with a history of the iron industry, the book contains fourteen other chapters dealing with: The Action of Air and Water upon Iron; The Action of Steam upon Iron; Various Theories of Corrosion; Is an Acid Essential to Corrosion? Factors Influencing the Rate of Corrision of Iron Exposed to Natural Forces; The Action of Acids upon Iron; The Action of Alkalies upon Iron; The Influence of Aqueous Solutions of Single Salts upon Iron; The Influence of Aqueous Solutions of Two or More Electrolytes upon Iron; The Action of Oils upon Iron; The Passive State of Iron; The Influence of Chemical Composition upon the Corrodibility of Iron; Electrical and Galvanic Action; The Relative Rate of Corrosion of Iron and Steel.

One criticism that might be made, is that the book would have been more commanding in appearance had the page size been 6×9 instead of 5×7½.—T. R. L.

Reinforced Concrete Construction in Theory and Practice. By Henry Adams, M.Inst, C.E., etc., late Professor of Engineering at the City of London College, and Ernest R. Matthews, Assoc. M.Inst. C.E., etc., borough engineer and surveyor of Bridlington. Published by Longmans, Green & Co., London. Size 6×9 inches; 310 pages; price $3.25.

In this volume the authors deal lightly with pure theory, and have only stated such theoretical principles as are needed to enable readers to understand the calculations necessary for beams, columns, and certain special constructions. On the other hand, they have evidently taken a great deal of trouble in the collection of particulars, including numerous illustrations of reinforced concrete structures in this country and abroad. While valuable for the useful summary of data and principles in the earlier chapters, it appears to us that the chief value of the book will be found in the records presented in the succeeding chapters. These deal with practical examples of construction in accordance with the best-known British, American, and foreign systems, the types of construction including reservoirs and tanks, culverts and conduits, swimming baths and other forms of municipal engineering work, railway bridges, tunnels, buildings, and permanent way construction, wharves, jetties, groynes, sea-walls, storage bins, retaining, sea and other walls, grand stands, and various types of building construction. The illustrations are very numerous, many of them having been reproduced from working drawings, which are more serviceable to technical readers than photographic views. Interspersed among the descriptive matter are notes which should be of practical service to municipal engineers, and the volume appropriately concludes with a chapter discussing matters connected with the practical execution of works in reinforced concrete.

Heat and Thermodynamics. By F. M. Hartman. Published by McGraw-Hill Book Company, New York; 336 pages; 6×9; fully illustrated; price $3.

The subject of thermodynamics has been written on by so many that there is very little outside of rearrangement that can be accomplished by a new writer. The preface to this book contains some hints that might be well followed by many instructors, outstanding among which is the following that perhaps illustrates the standpoint of the book: "It is the author's opinion that the best that can be done in any technical course is to thoroughly teach the fundamental principles underlying the subject, and that it is impossible to give a training which makes the student a practical engineer."

The book has taken up the theory of thermodynamics in a very clear manner, the arrangement being such that the student works from the purely theoretical to the more applied side of the subject, the final chapter on Steam Turbines giving a rather concise exposition of the theory underlying the construction and operation of steam turbines.

The transference of heat through solids is taken up from the usual standpoint of conductivity. It is not out of place to point out here that it is time some one included in a treatise, the method of calculating heat flow through solid bodies from the standpoint of thermal resistance as continually outlined by various investigators. The method is so simple when applied to electrical work as to merit its being taught to students.

As a text for the student, this book should be very easy o follow. especially if used in conjunction with a series of ectures.—T. R. L.

ndustrial Drawing and Geometry. By Henry J. Spooner; published by Longmans, Green & Co., London. Boards; size 6¾ × 9¼ ins.; 168 pp.; price, 75c.

This little volume comprises an introduction to the arious branches of technical drawing. It contains 620 figures nd 320 exercises, and is intended as a text book of geo- netrical and mechanical drawing in the curricula of ele- nentary and secondary schools and to lead up to works on nachine construction and drawing, on building construction nd other branches of technical drawing.

A B C of Hydrodynamics. By R. de Villamil; published by E. & F .N. Spon, London; size 5¾ × 8½; 132 pages; 48 illustrations; price $2.

This book is intended as an introduction to the study of Hydrodynamics. There is not very much that is new in t, but the facts are presented very clearly and concisely. Quotations are used throughout the book rather fully; the uthor states that the views on viscosity are based on those of Newton.

The Elements of Structures. By Geo. A. Hool, S.B., first edition; published by The McGraw-Hill Book Company, New York; cloth 6¼ × 9¼ ins.; 188 pages including index; price $1.75.

This forms the first volume of the Engineering Educa- ion Series prepared by the University Extension Division of the University of Wisconsin. It is published in two orms; as a regular text book and in assignment pamphlets or correspondence study work, with loose leaf binding. The present text is an excellent example of the character of the series. It covers the fundamentals of structures in a prac- ical way, assuming only an ordinary knowledge of mathe- matics, drawing and strength of materials. The book is ntended for students who have had an ordinary training in nathematics and has been developed solely with the idea of using it in correspondence study.

Standard Forms of Field Notes for Civil Engineers. By Charles C. Anthony; published by McGraw-Hill Book Company, New York; size 4½ × 7; 56 pages; price $1.

The object of this book is to present forms for note- aking and such necessary instructions in the use of them hat an engineer can take a complete set of notes and re- cord the results of a survey in neat and workmanlike manner. It is a very common thing to see an engineer called into the office to explain his notes to the draftsman, or a party returned to the field to get information that should have been taken in the original survey. This little volume should do much towards simplifying and standardiz- ing note-taking in the field. It is heartily recommended to all civil engineers and students.

Synchronous Motors for Power Factor Correction is the title of Special Publication R.L. 57, issued by the Railway and Lighting Department of the Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa. This book- let, which has an art cover contains some of the most valu- able, common-sense data on the phenomena of power factor and on the bad effects of low power factor and its power factor correction with synchronous motors that has ever been printed. That it is being distributed without charge and apparently at much expense, furnishes an illustration of the policy of some of the present-day manufacturing com- panies of spending considerable money to educate the pos- sible buyer as to the selection and application of equip- ment that is not generally understood.

Besides a discussion of power factor and its correction by Nicholas Stahl, the publication gives much specific data on and illustrates many synchronous motor installations made for improving low power factors.

Curves and diagrams are given whereby one can deter- mine with a few simple calculations, the capacity of a syn- chronous motor necessary to correct a given load from and to given power factors. Directions and diagrams are given for solving by inspection the other problems that arise in connection with power factor phenomena. The features of the booklet that will be appreciated by practical engineers is the simplicity of the treatment of the many examples illustrating the use of the data and curves. This book should be in the hands of every man that has to do with alternating current.

"5,000 Facts About Canada" for 1912. The 1912 edi- tion of that popular and indispensable booklet, "5,000 Facts about Canada," compiled by Frank Yeigh, the widely known writer and lecturer, and author of "Through the Heart of Canada," is now out and is replete with new matter, in- cluding an outline map of Canada, a calendar and the new census figures. In compact form is found a wealth of facts and figures of the Dominion that will provide a revelation of our natural resources and growth. The mass of informa- tion gathered with infinite pains, should be in the hands of every intelligent Canadian, and the wide sale and popularity of the publication is easily understood. Copies may be had for 25 cents from The Canadian Facts Publishing Company, 667 Spadina Avenue, Toronto.

The Signal Dictionary. 9 in × 12 in. 600 pages. 3,899 illustrations. Simmons-Boardman Publishing Company, New York and Chicago. Leather, $6. Cloth, $3.50.

The Railway Signal Association Signal Dictionary, first published in 1908, has been revised and published in the second edition (1911-12) under the supervision of a commit- tee of the association. The aim in revising the book, as stated in the preface, has been to "retain descriptions and illustrations of apparatus which, although no longer made, is and will remain for some time in rather extensive use, as well as to reflect the latest work of the manufacturers." That the book is not merely a catalogue of manufacturers' devices is shown, however, by the fact that it contains practi- cally all of the standards adopted by the Railway Signal Association and a great many standards of signal depart- ments of prominent railways of this country and England. Another change which will be found almost as valuable as the addition of the up-to-date apparatus and standards is the re-arrangement of the material in a form which is well adapt- ed for ready reference. The descriptive part of the book is divided into five sections which are clearly marked by title pages and subdivided so as to arrange each branch of the subject under distinct heads. The definition section has been amplified by the addition of a large number of the terms used in connection with the generating and distri- bution of alternating current. This part of the book con- tains full reference to descriptions included in the descrip- tive part, and a complete cross reference index is added. The divisions of the descriptive part are: (1) Signal Sym- bols and Signal Indications; (2) Block Signaling; (3) In- terlocking; (4) Highway Crossing Signals, and (5) Acces- sories. The last named division contains 18 subdivisions in which the apparatus and devices used in railway signal- ing are illustrated and described.

PUBLICATIONS RECEIVED.

The Prevention of the Pollution of Canadian Surface Water. By T. Aird Murray. A pamphlet issued by the Committee on Public Health of the Commission of Conservation, Canada, being a reprint of a series of three articles written for the Toronto Globe and published early in January, 1912. Copies may be obtained from James White, secretary, Commission of Conservation, Ottawa.

Report on the Mining Accidents in Ontario, 1911. By E. T. Corkill, chief inspector of mines. Bulletin No. 9, of the Bureau of Mines, Dept. of Lands, Forests and Mines, Ontario.

Fifth Annual Report of the Game and Fisheries Department, 1911, Province of Ontario.

Mechanical Stresses in Transmission Lines. By A. Guell. Bulletin No. 54, University of Illinois, Engineering Experimental Station. Copies may be obtained for 20 cents by addressing The Engineering Experiment Station, Urbana, Ill.

Inductance of Coils. By Morgan Brooks and H. M. Turner. Bulletin No. 53, University of Illinois, Engineering Experiment Station. Copies may be obtained for 40 cents by addressing The Engineering Experiment Station, Urbana, Ill.

Preliminary Review and Estimate of Mineral Production for Year 1911. By Wm. Fleet Robertson, Provincial Mineralogist. Preliminary review printed by authority of the Legislative Assembly of British Columbia.

Papers and Reports Relating to Minerals and Mining. Comprising statement by the Minister of Mines, report on the gold fields, report on coal mines, state coal mines, New Zealand.

CATALOGUES RECEIVED.

Municipal Supplies. Catalogue No. 41 of Mussens, Limited, Montreal. Listing their municipal machinery and equipment. Copies may be obtained from Mussens, Limited, Montreal.

Lea High-Duty Turbine Pumps. The Lea Equipment Company, manufacturers of high-duty turbine pumping machinery, 90 West Street, New York, forward Bulletin K, illustrating the different types of their turbine pump.

Railway Signals. The General Railway Signal Company, Rochester, New York, forward loose leaf catalogues A and G, mechanical, interlocking machines and accessories, and electric interlocking machines and accessories.

Pure Water.—The Roberts Filter Manufacturing Company, Darby, Philadelphia, Pa., forward latest catalogue illustrating their water filters, pressure and gravity types, and filter appurtenances. The catalogue contains a great deal of valuable data useful for design and estimating, as well as illustrations of many installations of their apparatus.

The Improved Concrete Machinery. Wettlaufer Bros., Toronto, Ont., forward catalogue illustrating different types of their concrete mixers and their block machines.

Pumps. The Luitwieler Pumping Engine Company forward their general catalogue No. 11, illustrating their system of non-pulsating pumping machinery. General offices and factory 122 Aimes Street, Rochester, N.Y.

Good Roads Machinery. The Sawyer-Massey Company, Hamilton, Canada, forward folder illustrating different machinery and apparatus made by them for use on good roads. This includes screens, crushers, portable bins, graders, scarifiers, etc.

Twist Drills. The Morris Twist-Drill & Machine Company, New Bedford, Mass., forward catalogue illustrating their drills, reamers, milling-cutters, taps, dies, etc.

THE TAR TREATMENT OF MACADAM ROAD SURFACES.

The following report by the city engineer (Mr. L. S. Mackenzie) was presented at the last meeting of the Bristol (England) Corporation.

In accordance with the instructions of your committee, your engineer has carefully studied the results so far of the tar treatment of macadam road surfaces, and he has prepared a statement showing the cost of road maintenance each year since the tar spraying was adopted in 1906, and for the sake of comparison has also shown on the statement the average cost of maintenance during the three years prior to the system being adopted. The expenditure during the current year up till the 11th January is also included, and on the basis of this expenditure he has estimated the total for the year; but, although this shows some very satisfactory results, he does not propose to draw any comparisons from these estimated figures, but to limit his remarks to the period terminating on 25th March, 1911.

The average cost of cleansing the whole of the streets in the three years prior to the adoption of tar treatment was $145,360; for the year ending March, 1911, the cost was $140,875, showing a saving of $4,485; but a more striking and satisfactory result is that no fewer than 15,852 fewer loads of slop and sweepings had to be carted to tip; this is very important, as a large proportion of this slop is pulverized road stone. The average cost of street watering in the three years above referred to was $21,255, while in the year ending March, 1911, it was only $14,035, a saving of $7,220. The cost of macadamizing, however, shows an increase of $6,075, but, whereas the total quantity of hard stone is practically the same, the weight of limestone used was 5,599 tons less. However, included in the amount is the cost of converting nearly three miles of old pitching to tar macadam, costing $8,000, also the laying down of an experimental length of "pitchmac," costing approximately $3,000, so that in reality the cost of macadam maintenance for the year is $5,000 less than the average for the three years prior to the treatment. Then, again, the cost of using tarred material for binding purposes has increased the cost of macadamizing. The cost of the tar treatment for the year under consideration was $37,880, and the total cost of the work on the road was $335,965, against $303,715, the cost prior to the use of tar showing an increased cost of $32,250, or, deducting the cost of special works, $21,250. During the period under revision 19 miles of private streets have been added to the highways.

Although from these statistics no actual saving can be shown, your engineer submits the following points for consideration:—

1. The dust nuisance has practically disappeared.
2. The surface of secondary roads has been enormously improved.
3. The streets generally are cleaner than ever they were before.
4. Watering and cleansing have been extended into outlying districts, where hitherto the water-cart had never been seen.
5. Tips are becoming fewer and farther away, tending to increase the cost of haulage.
6. Cost of material has increased.
7. Conditions of traffic have entirely changed, and it is impossible to say what extra cost the city might have been put to if the tar spraying had not been introduced.

It was remarked that on a well made road accommodating light traffic only, tar was an excellent coating; on a badly constructed surface a coating of tar made the road worse than ever.

EARNING AND OPERATION EXPENSES

The aggregate earnings of Canadian railways from all sources for 1911 were $188,783,493—an increase of $14,777,276 over 1910. This was equal to 8.7 per cent. Operating expenses amounted to $131,033,784, which sum was $10,628,343 larger than for 1910—or 8.8 per cent. Thus the increase in gross earnings was not quite equal to the increase in operating cost. The ratio of operating expenses to gross earnings was 69.4; or .2 higher than for the year preceding.

The difference between gross earnings and operating expenses was $57,698,708, as compared with $53,550,776 in 1910. This difference is popularly regarded as net operating income; but that is not a correct assumption. Certain deductions, such as taxes, rents, interest on funded debt, etc., must be allowed before the true net income is ascertained. That income represents the amount available for dividends and the balance carried forward to profit and loss.

The net earnings of $57,699,708 were equal to $2,271 per mile of line—an increase of $105 over 1910. In this connection it must not be forgotten that a considerable number of railways either failed to make ends meet or barely did so. More than 95 per cent. of the balance as between income and outgo, given above, was really earned by twelve reporting roads.

The amount paid out in dividends during the year was $30,577,740, of which $11,485,740 was on preferred and $19,092,000 on common stock. After all proper reductions had been made the amount carried forward to profit and loss for the year was $14,808,566.

The railways of Canada in 1911 earned $19,444,893 from outside operations, with expenses attached thereto of $14,150,464. This left a balance of $5,294,428 to be credited to profit on that account.

The gross earnings for 1911 were equal to $7,430 per mile of railway, showing an increase of $396 over the preceding year.

The earnings from passenger service per passenger train mile were $1.348, and from freight service per freight train mile $2.376.

The gross earnings in 1911 came from the following sources:—

	1911
Passenger	$ 10,566,393
Mails	1,869,413
Express	4,674,135
Baggage, parlor cars, etc.	1,207,555
Freight	126,570,533
Station and train privileges	826,251
Telegraphs, rents, etc.	3,018,709
	$188,733,493

Operating expenses in 1911 amounted to $131,034,784 or $10,629,344 more than for the year 1910. This increase was equal to 8·8 per cent. The operating expenses per mile of line were $5,158, showing an increase of $290 over 1910.

A comparison of gross earnings, operating expenses and net earnings per mile of line since 1907 gives the following result:—

	Gross earnings per mile	Operating expenses per mile	Net earnings per mile
1907	$6,535.64	$4,620.90	$1,914.73
1908	6,397.21	4,673.30	1,724.90
1909	6,017.89	4,339.53	1,678.40
1910	7,033.93	4,868.60	2,165.83
1911	7,430.45	5,158.85	2,271.64

The equipment reported for the year 1911 was as follows:—

	Number	Increase
Locomotives	4,219	140
Cars in passenger service	4,513	193
Cars in freight service	127,158	7,445
Cars in company's service	9,578	930

The aggregate mileage of revenue trains, passenger, freight and mixed, in 1911, was 89,716,533—an increase of 4,307,292 miles.

In addition, the mileage of non-revenue trains was 4,478,705. Of the revenue train mileage, 232,341 was classified as special.

The capacity of freight cars of the various classes, with a comparison for the years since 1907, is shown in the following statement:—

	1907		1908		1909	
	No.	Capacity in tons	No.	Capacity in tons	No.	Capacity in tons
Box	66,934	1,848,987	72,862	2,048,227	74,479	2,130,145
Flat	20,118	535,167	21,781	592,496	21,220	584,455
Stock	4,731	122,550	5,047	133,578	5,561	150,800
Coal	10,060	291,638	11,616	362,233	11,721	379,981
Tank	132	2,632	197	4,000	197	4,012
Refrigerator	1,745	48,745	2,423	69,000	2,465	71,085
Other	1,820	59,200	1,941	67,410	2,273	64,835
Total	105,540	2,908,903	115,867	3,277,394	117,916	3,385,313

MICROGRAPHICAL EXAMINATION OF METALS.

The advantages of the use of the microscope in addition to chemical analysis and mechanical tests in the examination of metals are set forth in an article by J. S. Primrose in a recent issue of Engineering. In the case of fractures, not only can the examination be made right up to the fracture itself, but also incorrect heat treatment or the presence of fatigue may be detected. Microphotographs are given illustrating the causes of a number of failures in iron and steel, which were revealed only by this method of analysis. These include the fracture of a wrought-iron angle bar which caused a boiler explosion; a mild steel plate which fractured on bending, although the test piece had passed the specification tests; a locomotive axle which broke while the engine was traveling at express speed; and a motor-car steering rod, the fracture of which was shown to be due to imperfect case-hardening. Attention is called to the fact that a piece of work may often be examined by the microscope before putting the material into service to determine whether it is in the proper structural condition for use.

ENGINEERING NOTES.

Japan.—Dr. Fengoku and party, president of the Inamashura Power Company, is making a tour of several cities in Canada and the United States to investigate the long distance transmission of electricity. It is understood that large contracts for the supply of electrical equipment are to be let in Canada or the United States at an early date.

Ottawa, Ont.—The promoters of the dry dock for Quebec have made an application to the Federal Government for an amendment of the charter in order that the subsidy of 3 per cent. may be made on the sum of $5,000,000 in place of $4,000,000 as first mentioned. There is a clause in the laws governing the granting of subsidies which does not allow government aid on a sum exceeding $4,000,000, and it is to overcome this that the promoters are requesting that the law be amended.

Manchester, England.—The municipal authorities have made preparations for a novel test that is expected to decide the question of the relative merits of gas and electricity as an illuminant of city streets. To each system has been allotted a certain section of the city for experimental purposes. The competition will be conducted by the city itself and will be entirely unbiased. Each faction must light the section which has been assigned to it, to the best of its ability. In making the final decision, the city council will take into account the initial expenditure, cost of maintenance, and quality of illumination.

Victoria, B.C.—Certain farmers resident in the vicinity of this city have made application to the municipal council that the city garbage, instead of being dumped at sea, as is done at present, be shipped to their districts and utilized as land manure and for fertilization purposes. The matter is in the hands of the health committee, who will make a report on the proposition as regards the sanitary side of the question.

Ottawa, Ont.—A deputation from North Bay waited upon the Federal Ministers to present a request that a canal be constructed from that municipality to the lakes. This would be in conjunction with the Georgian Bay canal scheme.

Calgary, Alta.—The plans for the new building to be erected for the management of the Canada Life Insurance Company show a building that should be a credit to any municipality. Messrs. Brown and Vallance, Montreal, the designers, have used the arch to an advantageous extent. The lower portion is composed of bold stone work, and from the lines started by the three main windows and door on the first floor (all similar in appearance) long panel windows make their way to the upper story. A cornice surmounts the whole and the effect is unique in many ways.

Quebec, P.Q.—The Canadian Northern Railway have introduced a novelty in the method of train propulsion in this country. A sub-company has been reorganized and will operate a passenger car to Lake St. Joseph from Quebec. The car will be operated by electricity generated on board by a gasoline engine. The car will run on the rails of the ordinary steam lines. It weighs forty tons, will make fifty miles an hour, will seat fifty at ordinary times, and will make from six to ten trips per day a distance of twenty-two miles.

Montreal, P.Q.—The motor boat show held in this city during the past few days, has brought out many interesting features among gas propelled craft and vehicles. Among these exhibits was an automatic starting auto truck that was so constructed as to use the surplus energy of the self-starter to operate electric search and tail lights and also to operate electric signs advertising the goods of the owner of the truck.

Montreal, P.Q.—Plans for the new Canadian Northern passenger station have been issued. The station will be one of the finest in America when completed, and will be one of the architectural attractions of Montreal. Access to the subway, through which the electric-driven trains of the railway will run, connecting the model city at the back of the mountain, and the business district of Montreal, will be obtained by means of stairways leading to platforms over the trains. An up-to-date system of ventilation will be employed to keep the air in the tunnel pure and fresh. The main entrance will be from Dorchester Street, about the middle of the block, but access to the new station will also be possible from St. Monique and Mansfield Streets, while another large entrance will be available on Lagauchetiere Street.

PERSONAL.

Mr. A. J. McPherson, city commissioner of Regina, has placed his notice of resignation before the municipal council.

Mr. C. W. P. Ramsey, who has been in the employment of the C.P.R for many years, has been appointed engineer of construction for eastern lines, with offices at Montreal.

Mr. E. L. Cousins, engineer to the Harbor Board of the city of Toronto, will make an inspection of several harbors along the waterfronts of certain cities in the United States.

Dr. M. Fengoku, Dr. J. Takashara and Mr. M. Ohiu spent a few days in Toronto to gather information relating to the hydro-electric system of Ontario. All these gentlemen are prominent Japanese. Dr. Fengoku is president of the Inamashura company which contemplates generating 50,000 electrical horsepower 150 miles from Tokio to supply that city. At the present time no attempts have been made to transmit current for long distances in Japan and the party has come to America in order to study the problem. Previous to coming to Toronto the party visited Schenectady, Buffalo and Niagara Falls.

OBITUARY.

The death of **Mr. David D. Drummond** has been announced. Mr. Drummond was vice-president of the Chicago Portland Cement Company; his death occurred at his home, Oglesby, Ill., on March 8th last.

James Newark Leitch, C.E., B.A.Sc., is dead from pleuro-pneumonia. He was engineer in charge of the Public Works Department of the New Government House in Toronto. Mr. Leitch was a son of James Leitch, Esq., K.C., chairman of the Ontario Railway and Municipal Board. He was 25 years of age.

MEETINGS.

A society has been formed in Regina with the intention of becoming the Saskatchewan branch of the Canadian Society of Civil Engineers. For the purpose of drawing up a constitution, a committee was formed to which the following representatives of the various local branches of engineer-

ing were appointed: A. J. MacPherson, chairman, ex-officio; Carpenter, Government; Smith, contracting; Ball, electrical; Wynne-Roberts, consulting; Blackburn, mechanical; Riley, surveyors; Thornton, city; Daniel, railways; Wenger, heating.

ANNUAL DINNER OF ENGINEERS' CLUB, TORONTO.

The Engineers' Club, of Toronto, held their annual dinner in the dining parlors of the club rooms on the evening of March 21st last. About eighty members were in attendance and listened with pleasure to the addresses of Dr. Ellis, Toronto University; Mr. C. H. Rust, city engineer, Toronto; Mr. A. F. Macallum, city engineer, of Hamilton, Ont.; Mr. C. H. Hays, and A. L. McAllister.

In addition to the above mentioned gentlemen, Mr. D. G. Boyd, Mr. R. A. L. Gray and Mr. Geo. C. Ruff entertained the meeting with singing and literary selections.

Mr. Willis Chipman, president of the club, occupied the chair.

At the meeting of the Engineering Society of the University of Toronto Mr. J. E. Ritchie was elected president of the association. Mr. William Curtis was elected to the office of first vice-president, and Mr. H. R. Mackenzie will be the treasurer of the organization during the coming year.

COMING MEETINGS.

CANADIAN INSTITUTE.—198 College Street, Toronto. Saturday Evening Lectures, 8 p.m. March 30th, "Spectral Lines—their Arrangement and Constitution," by Prof. J. C. McLennan, Toronto University. April 13th,—"Lantern Experiments on Reaction in Non-homogeneous Systems," by Prof. Kenrick, Toronto University.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE CLEVELAND ENGINEERING SOCIETY.—Regular Meeting, Tuesday, April 9th, 1912, Chamber of Commerce Bldg., Cleveland, Ohio. Symposium on the Elimination of Grade Crossings. F. W. Ballard, Secretary.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary. Professor C. H. McLeod.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary-Treasurer, R. W. Macintyre

QUEBEC BRANCH—Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving: Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—Secretary E. Brydone Jack. Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—Chairman, Geo. H. Webster: Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department. University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. V. Ross.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr, G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

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WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
3-25	Prime mover equipment, electric lighting equipment, etc., Moose Jaw, Sask.....(S.)	3-7
4-8	Paving, Port Arthur, Ont. .....(S.)	3-21
4-11	Grading, sanitary sewers, cement walks, etc., Lethbridge, Alta.....(P. & S.)	3-14

(Lethbridge plans and specifications are on file at The Canadian Engineer Office, 820 Union Bank Building, Winnipeg.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Calgary, Alta., designs for aqueduct	May 1.	Feb. 22.	70
Calgary, Alta., steel highway bridges	Apr. 15.	Mar. 14.	68
Fredericton, N.B., concrete substructure and approaches to bridges	Apr. 1.	Feb. 29.	59
Fredericton, N.B., culvert, McKenzie Hollow	Apr. 3.	Feb. 7.	89
Goderich, Ont., extension to breakwater and dredging	Apr. 15.	Mar. 21.	70
Halifax, N.S., garbage incinerator	Mar. 27.	Mar. 14.	59
Holland Island, B.C., lighthouse	Apr. 20.	Mar. 21.	60
Lethbridge, Alta., grading, sanitary sewers, etc.	Apr. 11.	Mar. 14.	70
Lorneville, N.B., extension to breakwater	Apr. 1.	Feb. 7.	60
Moose Jaw, Sask., turbo-generating set; generator	Mar. 30.	Feb. 7.	60
Moose Jaw, Sask., prime mover equipments, etc.	Mar. 29.	Feb. 7.	68
Moose Jaw, Sask., supply of coal	Apr. 13.	Mar. 21.	59
Moose Jaw, Sask., laying sewer and water mains	Mar. 29.	Mar. 21.	59
Niagara Falls, Ont., pavement	Apr. 1.	Mar. 21.	68
Oakville, Ont., sewage disposal works	Apr. 1.	Mar. 14.	68
Ottawa, Ont., alterations to fuel testing building	Apr. 9.	Mar. 21.	60
Point Atkinson, B.C., concrete tower, etc.	Apr. 20.	Mar. 21.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Port Arthur, Ont., paving	Apr. 8.	Mar. 14.	68
Prince Albert, Sask., sewer and waterworks	Mar. 29.	Mar. 14.	72
Saskatoon, Sask., pavement	Apr. 5.	Mar. 14.	68
Saskatoon, Sask., labor on storm sewers	Mar. 29.	Feb. 29.	72
Saskatoon, Sask., sewer and water construction	Mar. 29.	Feb. 29.	72
St. Jerome, Que., hydro-electric installation		Feb. 7.	68
St. Thomas, Ont., Port Stanley waterworks	Mar. 29.	Mar. 21.	70
Sudbury, Ont., sewers, etc.	Apr. 17.	Mar. 21.	60
Sydney Mines, C.B., annex to hospital	Mar. 30.	Mar. 21.	60
Toronto, Ont., storm overflow sewer, Garrison Creek	Apr. 9.	Mar. 21.	72
Toronto, Ont., waterworks materials	Apr. 2.	Mar. 21.	72
Welland, Ont., road machinery	Apr. 2.	Mar. 21.	60
Welland, Ont., stone	Apr. 2.	Mar. 21.	60
Westmount, B.C., sewer and paving, Western Ave.	Mar. 28.	Mar. 21.	68
Winnipeg, Man., drawings for Parliament Buildings	Mar. 31.	Jan. 25.	70
Winnipeg, Man., well turbine pumps	Apr. 1.	Mar. 14.	60

TENDERS.

Calgary, Alta.—Tenders will be received until May 1st, 1912, for concrete structures in about half of the area comprising the eastern section of the C.P.R. Company's Irrigation Block, Alberta. Plans, specifications, and full information will be furnished after April 1st, 1912, on application to A. S. Dawson, Chief Engineer, C.P.R., Calgary, Alta. (Advt. in Canadian Engineer).

Hamilton, Ont.—Separate tenders will be received until 5 p.m., April 10th, 1912, for the laying of a 48-inch steel intake pipe 2,200 feet in Lake Ontario from the Hamilton waterworks filtering basins, with gate house, crib, piling, etc. Also for the laying of a steel and concrete conduit from the Beach Pumping Station to the filtering basins, with gate house, piling, manholes, etc. Specifications, etc., on file at the office of A. F. Macallum, City Engineer. S. H. Kent, City Clerk, Hamilton, Ont.

Hamilton, Ont.—Tenders for approximately 6,500 concrete poles will be received by the City Clerk, Hamilton, up to 10.30 a.m., April 10th, 1912. Plans and specifications may be secured at the Hydro-Electric Department Office, City Hall, Hamilton. E. I. Sifton, Consulting Engineer; Geo. H. Lees, Mayor.

London, Ont.—Specifications and forms of tender for the following material may be obtained on application:—100 tons 18-inch cast-iron pipe; 450 tons 12-inch cast-iron pipe; 25 tons 10-inch cast-iron pipe; 5 tons 8-inch cast-iron pipe; 65 tons 4 to 6-inch cast-iron pipe; 35 tons special castings of various types and sizes. H. J. Glaubitz, General Manager.

Medicine Hat, Alta.—Tenders for the construction of a brick and stone church for the parish of St. Barnabas, Medicine Hat, will be received up to noon of April 12, 1912. Plans and specifications may be seen in the office of Turpin Bros., Medicine Hat; at the Builders' Exchange, Calgary, and at the office of James C. Teague, architect, 312 Dominion Bank Bldg., Calgary. J. H. Collier, Secretary to Vestry, Medicine Hat, Alta.

Montreal, Que.—Tenders will be received until April 3, 1912, for laying a water pipe for the village of Dorion. Plans and specifications may be seen at the office of the engineer. V. H. Dupont, 62 St. James, Montreal.

Moose Jaw, Sask.—Tenders will be received up to noon of April 17th, 1912, for contract "D" consisting of :—

Sec. 1—Water-tube boilers and accessories.
Sec. 2—Mechanical draft equipment.
Sec. 3—Fuel economizer.
Sec. 4—Coal and ash handling equipment.

Specifications and all information obtained on application to J. D. Peters, Electrical Superintendent, Moose Jaw. City Commissioners, Moose Jaw.

Ottawa, Ont.—Tenders will be received by the Department of Public Works, up to 4 p.m., of April 3, 1912, for in-

terior fittings post office, Port Colborne, Ont. Plans and specifications to be seen on application to Mr. Wm. Armstrong, caretaker, Port Colborne, Ont.; Mr. T. A. Hastings, Clerk of Works, Postal Station F, Toronto, and at Department of Public Works.

Ottawa, Ont.—Tenders will be received at the office of Public Works until April 9th, 1912, for the construction of machinery for a 3½ yard dipper dredge. Plans, etc., at offices of J. L. Michaud, Esq., District Engineer, Merchants' Bank Building, Montreal; J. G. Sing, District Engineer, Confederation Life Building, Toronto, and Office of Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the supply of 5,000 tons (of 2,000 lbs. per ton), more or less best quality screened ¾ lump steam coal, to be delivered where mentioned in form of tender, will be received until April 10, 1912, at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa. Specifications, etc., at the offices of J. L. Michaud, Esq., District Engineer, Merchants' Bank Building, St. James Street, Montreal; J. G. Sing, Esq., District Engineer, Confederation Life Building, Toronto, and Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received by the Department of Public Works, Ottawa, until April 3rd, 1912, for dredging required at Toronto, Ont. Specifications, etc., at the office of the Secretary, Department of Public Works, Ottawa. (See advt. in Canadian Engineer).

Ottawa, Ont.—Tenders will be received until April 16th, 1912, for the construction of an extension wharf at Lion's Head, Bruce County, Ont. Plans, etc., at the offices of J. G. Sing, Esq., District Engineer, Confederation Life Bldg., Toronto; H. J. Lamb, Esq., District Engineer, Windsor, Ont.; on application to the Postmaster at Lion's Head, Ont., and office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received by the Dept. of Public Works, until April 9, 1912, for dredging required at St. John Harbor, N.B. Combined specifications and form of tender can be obtained on application to the Secretary, Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until April 15, 1912, for the construction, in accordance with the plans and specifications of the Commissioners, of a reinforced concrete sewer at St. Boniface. Plans, etc., may be obtained at the office of Mr. Gordon Grant, Chief Engineer, Ottawa, and Mr. A. G. Macfarlane, Dist. Engineer, St. Boniface, Man. P. E. Ryan, Secretary, the Commissioners of the Transcontinental Railway, Ottawa.

Ottawa, Ont.—Tenders will be received until April 18, 1912, for the construction of a wharf and dredging basin at Sarnia, Lambton County, Ont. Plans, etc., at the offices of H. J. Lamb, Esq., Dist. Engineer, Windsor, Ont.; J. G. Sing, Esq., Dist. Engineer, Confederation Life Bldg., Toronto; and on application to the Postmaster at Sarnia, Ont. R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Toronto, Ont.—Tenders will be received until March 29, 1912, for the several trades required in the erection of new school building on Manning Avenue; new school building on Morley Avenue, and for vacuum cleaning apparatus complete for five schools; manual training fittings at Brown School. Specifications, etc., at the office of the Superintendent of buildings, City Hall. W. W. Hodgson, Chairman of Committee; W. C. Wilkinson, Secretary-Treasurer.

Toronto, Ont.—Tenders will be called for shortly for the erection of the new St. Alban's Cathedral. Messrs. Symons & Rae, architects.

Toronto, Ont.—The Chairman of the Board of Control, City Hall, Toronto, will receive tenders for the construction of concrete walks, up to noon of April 19, 1912. Specifications may be seen and forms of tenders obtained at the office of the City Engineer, Toronto. G. R. Geary (Mayor), Chairman of the Board of Control, Toronto.

Vancouver, B.C.—Tenders will be received until April 2nd, 1912, for the construction of a section of the Bridge Street trunk sewer, between Tenth and Sixteenth Avenues, and for a section of the China Creek trunk sewer, from Seventh Avenue to Eleventh Avenue. Plans and specifications for these sewers may be seen at the City Engineer's office, City Hall. Wm. McQueen, City Clerk, City Hall, Vancouver.

Vernon, B.C.—Tenders will be received until April 8th, 1912, for the supply and delivery of 60 cast-iron manhole frames and covers, complete with either cast-iron or galvanized iron mud baskets. D. G. Ttate, City Clerk, Vernon, B.C.

Victoria, B.C.—Tenders for sections of or for the whole work will be received up to noon March 30, 1912, for the construction and completion, ready for use, of a main trunk sewer and outlet, from the inter-municipal boundary on Foul Bay Road, to Bold Point, Shoal Bay. Plans, etc., obtained from Mr. R. Fowler, C.E. Municipal Engineer, 10 Law Chambers, Bastion Street, Victoria, B.C. J. S. Floyd, C.M.C.

Victoria, B.C.—Tenders will be received up to noon of March 30th, 1912, for supplying cast iron water pipe, special castings. Plans, etc., with Mr. R. Fowler, C.E., Municipal Engineer, 10 Law Chambers, Bastion Street, Victoria.

Welland, Ont.—Tenders are wanted for an addition to the Welland County Industrial Home, Welland, tenders to be received until the 3rd of April, 1912. Plans and specifications at the office of T. L. Nichols, Architect, Welland. A. C. Wilson, Esq., Chairman Industrial Home Committee.

Westmount, Que.—Tenders are invited for the following supplies for the year commencing 1st May, 1912:—

(a) Cement.
(b) Sand.
(c) Crushed stone.
(d) Paving blocks.
(e) Sewer pipes.
(f) Bricks.
(g) Farm tile.
(h) Coal.

Specifications, etc., can be obtained at the office of Archibald Currie, City Surveyor, Westmount. Tenders will be received by City Clerk, up to noon of April 3rd, 1912.

Winnipeg, Man.—Tenders will be received until April 18th, 1912, for supply of labor and materials required in the erection of a machine shop at city yards, Ross Avenue and Tecumseh Street. Plans, etc., at office of City Engineer, 223 James Avenue. M. Peterson, Secretary, Board of Control Office, Winnipeg.

CONTRACTS AWARDED.

Fredericton, N.B.—The contract for the construction of the Stone Ridge bridge, in the parish of Douglas, has been awarded to Mr. William R. Fawcett, of Temperance Vale. The contract price was in the vicinity of $2,500. Mr. A. E. Smye, of Alma, Albert county, has secured the contract for the construction of the Titus Bridge at Upham, King's county, at a contract price of $2,400.

Guelph, Ont.—The Water Commissioners have awarded the following contracts for the supply of water works material: Galvanized iron pipe, the Bond Hardware Co.; brass goods, Miller, Limited, London; valves, Kerr Engine Co., Brantford; cast-iron pipe and specials, Gartshore-Thompson, Hamilton; valve boxes, Kerr Engine Co., Walkerville.

London, Ont.—The London & Lake Erie Transportation Company has signed a contract with the Hydro-Electric Commission for five hundred or more horse-power, at $28 per horse-power, $10,000 will be spent on new cars and other equipment.

Northern Ontario.—Messrs. McCafferty and McQuigge, Toronto, have been awarded the contract for the construction of the right-of-way for the Temiskaming Railway Branch into Elk Lake. Their price was about $180,000. The line comprises about 28 miles, from Earlton to Elk Lake, with a maximum gradient of six feet in one thousand. The commission will lay the ties, steel and other incidentals of the permanent way.

Port Arthur, Ont.—Messrs. Barnett & McQueen Company have received a contract to remodel the C.P.R. Elevator "D." The storage capacity will be increased 1,600,000 bushels, making a total capacity of 3,580,000 bushels. Contract price, $400,000.

Port Arthur, Ont.—The Canadian Pacific Railway Company has awarded Messrs. James Whalen and L. H. Wallace the contract for the construction at the local yards of a steel stern wheel steamer for service on Kootenay Lake, British Columbia. Messrs. Whalen and Wallace have also secured a contract for the construction of two large Scotch boilers and complete boiler room outfit for the lake steamer, Turret Crown. These boilers will be 14 feet diameter and 11 feet long.

Barrett Specification Roofs

"Colonade" Apartments, Kansas City, Mo.
Sellers & Marquis, Roofers.
J. W. McKecknie, Architect.

Best for Apartment Houses.

THE "COLONADE" apartments in Kansas City, Mo., illustrated herewith, have Barrett Specification Roofs.

The owners selected this kind of roofing because they wanted first of all the least expensive roof which would give *proper protection.*

As a Barrett Specification Roof will last 20 years and over without care or attention and as its cost is less than that of any other permanent roof covering, they made no mistake on that point.

The owners wanted *low annual charges,* and Barrett Specification Roofs were satisfactory in that respect as they require no painting or care.

The owners also wanted *proper protection against fire* and as these roofs are considered by fire underwriters as slow burning construction, and as such take the base rate of insurance, everything was satisfactory on that point.

It's always the same story—when ultimate costs and satisfactory service are carefully considered, Barrett Specification Roofs are selected.

Further information about Barrett Specification Roofs will be supplied free on request.

Special Note

We advise incorporating in plans the full wording of The Barrett Specification, in order to avoid any misunderstanding.

If any abbreviated form is desired however the following is suggested:

ROOFING—Shall be a Barrett Specification Roof laid as directed in printed Specification, revised August 15th, 1911, using the materials specified, and subject to the inspection requirement

The Paterson Manufacturing Co., Limited

Montreal Toronto Winnipeg Vancouver St. John, N.B. Halifax, N.S.

Saskatoon, Sask.—Mr. W. F. Lee, Winnipeg, has the contract for supplying the city of Saskatoon with approximately 5,000 barrels of Portland cement, Mr. Lee's price being $2.38, net.

Vernon, B.C.—Messrs. Fraser, Williams, Stitt and Mathieson, Pender St., Vancouver, the lowest tenderers for the construction of vitrified pipe sewers, have been awarded the contract, their price being $8,795.

Welland, Ont.—The contract for the construction of approximately 37,000 sq. yds. of street pavement in the town of Welland, has been awarded to Mr. Chas. H. Kaumeir, of Port Huron, Michigan. (For full particulars, prices, etc., see the regular issue of The Canadian Engineer, March 28th).

Winnipeg, Man.—Apartment block on Clarke Street; A. Jameson, building contractor; S. D. Richardson, owner; estimated cost, $75,000.

RAILWAYS—STEAM AND ELECTRIC.

Brantford, Ont.—Plans have been filed by the Grand Trunk Railway for a five-mile cut-off connecting the main line and Tillsonburg branch by a short route through the grounds of the Ontario Institute for the Blind. Work will be commenced this spring. The new line will eliminate 20 level crossings around the city, and will give the company a terminal depot for all branches. A large tract of new industrial land will be opened up. The cost of the cut-off, which includes a new bridge 300 feet long over the Grand River, will be about $200,000.

Calgary, Alta.—The engineer to the Railway Commissioners will prepare a report on the proposed railway lines from Hope to mile 28 and from Coquitlam Summit to Hope. Two companies have surveyed lines over the same ground.

Galt, Ont.—The Galt-Port Dover line has received a bonus from the Federal Government. This line is to be 58 miles in extent and will be known as the Lake Erie and Northern Railway.

Province of Ontario.—The new line of the Canadian Pacific Railway, between Toronto and Montreal, the contract for which has recently been let, will branch off from the present C.P.R. line at Glen Tay, 15 miles west of Smith's Falls, and go thence south-west to Belleville, whence it will parallel the Grand Trunk line along the lake shore, returning to the C.P.R.'s present line at Agincourt for entrance into Toronto. By thus planning the line the C.P.R. will get entrance into every important town between Montreal and Toronto now served exclusively by the Grand Trunk. The C.P.R.'s new line will be laid with 85 pound rails.

Ottawa, Ont.—The Federal Government have inserted an item of $22,927,200.00 to be used in subsiding the following railways:—

For a line from St. John to Grand Falls,—228 miles.

From Milton to Caledonia, N.S.—30 miles.

To the l'Avenir and Melbourne Railway Company, from Melbourne to Drummondville—33 miles.

To the Ha Ha Railway Company in Chicoutimi County—40 miles.

From Ste. Agatne des Monts to Howard, county of Argenteuil—15 miles.

Interprovincial and James Bay Railway Company, from Temiskaming to the De Quinze River—50 miles.

To the Canadian Northern Quebec Railway Company, from Arundel to Preston and Hartwell—30 miles.

To the Quebec and Saguenay Railway Company, from St. Joachim towards Seven Islands—170 miles.

For a line from a point near Montreal to a point near Mile 837 west of Moncton on the National Transcontinental —200 miles.

To the Algoma Central and Hudson Bay Railway Company for three branches—275 miles. One from the Soo to a point on the Canadian Pacific Railway between White River and Dalton; a second from Michipocoten Harbor to the main line of the Canadian Pacific Railway, and the third from a point on the Canadian Pacific Railway towards the National Transcontinental Railway.

To the Algoma Eastern Railway Company, 106 miles from a point between Little Current and Sudbury towards the Algoma Central and Hudson Bay Railway, 76 miles, and from a point near Sudbury northerly, 430 miles.

To the Tillsonburg, Lake Erie and Pacific Railway Company, from Ingersoll to Stratford, 35 miles.

To the Lac Seul, Rat Portage and Keewatin Railway Company, from Kenora to the line of the National Transcontinental Railway, 22 miles.

To the Toronto, Lindsay and Pembroke Railway Company, from Golden Lake to Bancroft, 51 miles.

To the Canadian Pacific Railway from Toulon to a point on the Icelandic River, 35 miles.

To the Vancouver, Westminster and Yukon Railway Company, from Vancouver northerly, 109 miles.

To the Kootenay Central Railway Company, from Golden to a point on the British Columbia Southern near Jukeson, 175 miles, and from Caithness towards the international boundary, 25 miles.

To the Kettle Valley Railway Company, from Grand Forks up the North Fork, 50 miles.

To the Esquimalt and Nanaimo Railway Company, from Wellington to Alberni, 60 miles; from McBride Junction to Sandwich, 45 miles, and from Sandwich to Campbell River, 38 miles, in all 143 miles.

For a line from the Esquimalt and Nanaimo Railway Company near Campbell river toward Fort George, on the Grand Trunk Pacific Railway, 100 miles.

New Subsidies.

To the Fredericton and Grand Lake Coal and Railway Company, for a line from Gibson, on the Intercolonial Railway, to Minto, together with a branch line to Marysville, 35 miles.

To the Great Northern Mining and Railway Company, from Little River through Belle Marche to Eastern Harbor, 3 miles.

To the Southampton Railway Company, from Millville to Pokiok Bridge, on the St. John River, 13 miles.

To the Northern New Brunswick and Seaboard Railway Company, from Drummond Mines, Gloucester county, to the Intercolonial Railway, thence to Alston Point or Carron Point, Bathurst Harbor, 26 miles.

To the North Shore Railway Company, for the following lines: (a) From Adamsville, Kent county, to Snowshoe Lake, connecting with the Grand Trunk Pacific, 20 miles; (b) from Beersville, via Roxton, to Richibucto Head, 20 miles.

For a line of railway from Albert Mines, via Hillsborough to Moncton, 22 miles.

To the Quebec Central Railway Company for the following lines: (a) For an extension from a point (30 miles from St. George) in Dorchester County, to a point in the Parish of St. Sabine, County of Bellechasse, 1.34 miles; (b) for an extension from St. Sabine to Doime, County of L'Islet, 50 miles.

To the Canada and Gulf Terminal Railway Company, from Matane, easterly, to Gaspe Basin, 200 miles.

To the Grand Lake and Belle River Railway Company, from the National Transcontinental Railway at Belle River to 21 Mile Bay, or to Rabbitt Lake on the Ottawa River, in Pontiac County, 45 miles.

To the St. Charles and Hudson River Railway Company, from the main line of the Quebec and Lake St. John Railway at Indian Lorette, to Stoneham, 7½ miles.

For a line of railway from the National Transcontinental Railway at or near mileage 837, west of Moncton, to the mouth of the Nottaway River, on James Bay, 300 miles.

To the Simcoe, Grey and Bruce Railway Company, from Orillia to Kincardine, 50 miles.

To the Algoma Central and Hudson Bay Railway Company, between its junction with the Canadian Pacific Railway and with the National Transcontinental Railway, 65 miles.

To the Rainy River Radial Railway Company, from Fort Frances, on Lake of the Woods, to the mouth of the Little Grassey River, 50 miles.

To the Lake Erie and Northern Railway Company: (a) From Galt to Port Dover, 58 miles; (b) from Paris to Ayr, 10 miles; total, 68 miles.

To the Bruce Mines and Algoma Railway Company, from Rock Lake Mine to the Canadian Pacific Railway, 50 miles.

To the Manitoba and Northwestern Railway Company, from Hamiota to Birtle, 30 miles.

To the Alberta Pacific Railway Company, from Cardston to the Crow's Nest Pass branch of the Canadian Pacific Railway, thence to the Porcupine Hills, towards Calgary, 100 miles.

48 in. CONTINUOUS STAVE LINE.

Manufacturer of
Galvanized Wire Machine Banded
WOOD STAVE PIPE
CONTINUOUS STAVE PIPE
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For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

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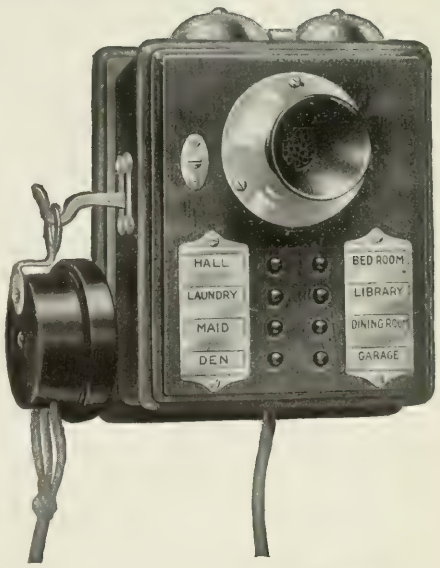
An Interphone System is the latest, most sanitary and approved method of inter-communication. It replaces the old-fashioned speaking tube which was never anything more than a receptacle for dust and dirt.

Owing to the quickness with which instructions can be given, orders can be transmitted and received almost instantly.

All the advantages of a personal interview are obtained without travelling from one place to another.

The system is available for use at all hours of the day or night independent of an operator, hence no operating expenses.



BETTER WRITE TO-DAY FOR BULLETIN 1061.

THE Northern Electric AND MANUFACTURING CO. LIMITED

Manufacturer and Distributor of Telephone Apparatus, Electrical Supplies and Fire Alarm Apparatus for every possible need.

MONTREAL TORONTO WINNIPEG REGINA CALGARY VANCOUVER

To the Burrard Inlet Tunnel and Bridge Company: (a) From Eburne to Seymour Creek, 10 miles; (b) from Seymour Creek to Deep Cove, 5 miles; (c) from Seymour Creek to Horseshoe Bay, 14 miles; (d) from Pender Street, Vancouver, to North Vancouver, 3 miles.

To the Grand Trunk Railway Company: From Harte to Brandon, 25 miles.

To the Caribou, Barkerville and Willow River Railway Company: From a point on the Grand Trunk Pacific, near Barkerville, 87 miles.

To the Naas and Skeena River Railway Company: From the Nasoga Gulf to Ground Hog Mountain, 100 miles.

To the Kettle Valley Railway Company: From Penticton to a point on the international boundary, 50 miles.

To the Calgary and Fernie Railway Company: From Calgary to Fernie, 100 miles.

Welland, Ont.—The first completed section of the Niagara, Welland and Lake Erie Railway was placed in operation on March 23rd last. The road was constructed by Mr. Hendrick Leitch, C.E.

LIGHT, HEAT AND POWER.

Galt, Ont.—The Hydro-Electric Department will present plans for an ornamental street lighting system to the city council at an early date.

London, Ont.—The management of the London and Lake Erie Railroad have signed a contract for the supply of 500 horsepower from the hydro-electric commissioners. The price quoted is $28 per horsepower. $10,000 will be spent on new cars and equipment.

Winnipeg, Man.—A report from this city states that the Winnipeg Electric Company has been sold and is now under the control of United States capital. The Manitoba Power Company are the purchasers and the report further mentions that the sub-companies are included in the sale. A complete appraisement of the value of the Winnipeg Electric Company is now being made by Messrs. Foster and Richardson of J. G. White & Co., of New York. A further staff is at work on plans of proposed extensions and developments, including that of the Big Bonnet Falls on Winnipeg River which will be carried out after re-organization at an estimated cost of $14,000,000. Rudolph E. F. Flinsch, treasurer of Messrs. White & Co., is in charge of the financial department of the work representing New York bankers whose names will appear later. Joseph R. Choate, Jr., of New York, and W. R. Mulock, of Winnipeg, are attending to the legal details. The price of the purchase is not made public, but is considered to be a large sum above $24,000,000.

GARBAGE, SEWAGE AND WATER.

Calgary, Alta.—The municipal engineering department have prepared plans for a water filtration plant to cost $200,000. The municipal council have not decided to install the plant as yet.

Galt Ont.—A project to erect a dam across the river at a cost of $3,000 is being discussed. There would follow this, if constructed, considerable river improvement work.

Moose Jaw, Sask.—Tenders for the construction of a reservoir have been placed before the Water Commissioners. They include the following:—

Archibald, Winnipeg	$38,175
Archibald, Winnipeg, alternative	44,075
W. Manders, Moose Jaw	50,000
Wilson, Townsend & Saunders, Hurst Engineering and Construction Co., Winnipeg	56,000
Moose Jaw Construction Company	34,352
Atlass Construction Company, Montreal	49,100
Atlass Construction Company, Montreal, alternative	52,000
W. Newman Company, Winnipeg	41,900
Navin Bros., Moose Jaw	36,973
Navin Bros., Moose Jaw, alternative	41,000

Petrolea, Ont.—The Water Commissioners of this town will receive applications for the position of waterworks engineer up to noon on March 27th next. Applicants must hold a stationary engineer's certificate and state salary required. Mr. John McHattie is secretary of the commission.

St. Catharines, Ont.—The board of works will seek authority to issue debentures for the sum of $40,000 to be used in sewer construction work. R. D. Brown, city engineer.

Toronto, Ont.—The municipal council intend to install the following water works material:—

Two 36-inch mains under tracks, main pumping station to Front Street	$44,459 00
42-inch main along Front Street to Bathurst Street	55,048 00
24-inch main along Niagara Street to Queen Street	33,535 00
36-inch main cross town line, Beverley Street to Sumach Street	148,477 00
Two 15,000,000-gallon triple-expansion engines, including buildings and connections	350,000 00

The existing debenture debt of the city (not including the Local Improvement Debt) is as follows:—

General Debenture Debt		$26,415,642 30
Water Works Debt	$9,120,321 22	
Debt for Electric Power Distribution Plant	4,950,000 00	
		$14,070,321 22

BUILDINGS AND INDUSTRIAL WORKS.

Calgary, Alta.—It is reported that the Pioneer Tractor Company will erect a plant in this city. Dr. Wheelock, of Winona, Wisconsin, is interested in the matter.

Calgary, Alta.—The Calgary Herald intend to erect a ten-story building on the corner of Seventh Avenue and First Street West. It will be of concrete and steel construction.

Coquitlam, B.C.—The Canadian United Lumber Company have prepared plans for the erection of a new mill in this town. The Western Canada Power Company will supply the power to operate the machinery.

Edmonton, Alta. — Negotiations have been opened between the municipal authorities and Mr. J. S. Brody as to what location may be secured for the construction of a mattress factory.

Fredericton, N.B.—The municipal council will consider the question of erecting a new fire hall. Ald. Cruickshank is chairman of the fire committee.

London, Ont.—The Hydro-Electric Commissioners will erect a storage building and patrol house in this city. The building will be erected on Horton Street, adjacent to the city's pumping station, and will be large enough to accommodate the water board's workshop. It is to be erected for the board of water commissioners.

Medicine Hat, Alta.—The Ogilvie Milling Company have decided to erect a milling plant in this city. The contract between the company and the municipality calls for the company to spend half a million dollars in the construction of a three thousand barrel flour mill and an oat meal mill and a cereal plant. The city gives free natural gas for ten years and a free site.

Montreal, P.Q.—A report states that a new car construction company are considering the erection of plant in this city. No particulars or names are mentioned in the report.

Province of Ontario.—The Provincial Government have allowed for the following expenditures in their supplementary estimates:—Victoria harbor (additional), $30,000; Acton, public building, $10,000; Barrie, public building (additions and alterations), $15,000; Belleville, public buildings (improvements), $2,500; Bowmanville, public buildings (improvements), $2,000; Brantford, new public buildings, $50,000; Chesley, public buildings, (revote), $15,000; Collingwood, public buildings, $25,000; Dresden, public building, tower clock, $2,000; Dundas, public building, $20,000; Fort William, drill hall, $30,000; Fort William, Customs house and examining warehouse, $50,000; Grimsby, public buildings $10,000; Hamilton, public building (extension and improvements), $22,000; Hespeler, public building, $10,000; Lakefield, public building, $10,000; Lindsay, public building, tower clock, etc., $4,500; Lindsay, drill hall, $25,000; London, postoffice (improvements), $10,000; Markham, public building (additional land), $2,000; Midland, public building (additional amount), $20,000; Milton, public building, $5,000; Mitchell, public building (additional amount), $2,000; Newmarket, public building, $25,000; Orillia, drill hall, $30,000; Oshawa, drill hall, $30,000; Ottawa, new drill hall, $50,000; Palmerston, public building, $10,000; Paris, public building, tower and clock,

THE TRIPLEX BLOCK

A Triplex Block hung from a temporary rigging and used for laying pipe.

What is the Life of a Triplex Block?

WE don't know. Triplex Blocks built by the Yale and Towne Co. at the very beginning—twenty-five years ago—are still in actual use. The Triplex Block of to-day possesses greater lasting powers. With its steel parts—its chain superior to any other—its non-wearing gear movement—and the guarantee of a rigorous test before shipment under a fifty per cent. overload. It will outlast the man who buys it, no matter how young he may be.

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Fairbanks Standard Scales — Fairbanks-Morse Gas Engines
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MONTREAL ST. JOHN OTTAWA TORONTO WINNIPEG
CALGARY SASKATOON VANCOUVER VICTORIA

$3,000; Perth, public buildings, $15,000; Peterboro, postoffice building (addition to), $2,500; Picton, armory, $20,000; Port Hope, public building (improvements), $7,500; Port Arthur, Customs house and examining warehouse, $60,000; Preston, public building, $10,000; Shelburne, public building, $5,000; Steelton, public building, $5,000; Toronto, postoffice (additional story), $25,000; Toronto, Customs examining warehouse, $300,000; Toronto, east postal station "G," $50,000; Toronto, postal station (vicinity of College street and Spadina avenue), $50,000; Toronto North, postal station, $25,000; Walkerville, public building, $15,000; Wallaceburg, public building (revote $15,000), $25,000; Watford, public building, $5,000.

Harbors and rivers—Beaumaris, construction of wharf (revote), $20,000; Beaverton harbor (improvements), $15,000; Belleville harbor (improvements), $50,000; Burlington, revetment wall, etc., $25,000; Cobourg, extension of west pier, $25,000; Collingwood harbor (improvements), $75,000; Goderich harbor (improvements), $50,000; Hamilton, harbor (improvements), $200,000; Kincardine, harbor at north end of north pier, $10,000; Kingston, harbor (improvements), $100,000; Orillia, wharf, $4,000; Owen Sound (improvements), $25,000; Parry Sound, wharf, $25,000; Picnic Islands (improvements to channel), $100,000; Picton, harbor (dredging), $19,000; Port Burwell (improvements to harbor work, $50,000; Port Stanley, harbor (improvements), $50,000; Rainy River, (improvements), $60,000; Sault Ste. Marie, harbor (improvements), $150,000; Telegraph and Nigger Islands; (dredging), $40,000; Thornbury, harbor (improvements), $29,000; Toronto, harbor (improvements—further amount required), $17,000; Whitby, harbor (improvements), $20,000.

Preston, Ont.—B. W. Ziemann is preparing to erect a $10,000 block in this town. A report states that the store portion of the building will be used for retail dry goods purposes.

Saskatoon, Sask.—The Western Foundry and Machine Company are preparing to manufacture sewer pipes. They will erect a new warehouse and have purchased the right for Saskatchewan for the manufacure and sale of the Thomas glazed cement sewer pipe and have engaged an expert sewer pipe maker as foreman of the new department. The company are making the manhole covers used in connection with this city's sewer system. Mr. A. E. Small is general manager of this company.

Saskatoon, Sask.—The municipal council have decided to prepare a by-law to raise the sum of $100,000 for the purposes of erecting a new public library.

Stratford, Ont.—Mr. Ben Williams proposes to erect a knitting factory and has asked the municipal council to grant him a loan of $8,000. It is probable that a by-law will be submitted to the ratepayers at an early date.

Toronto, Ont.—The municipal council intend to erect the following fire halls:—

Greenwood Avenue Fire Hall	$30,000 00
Purchase price of site	7,064 00
Wychwood Fire Hall	30,000 00
Purchase price of site	7,004 00
Roncesvalles Avenue Fire Hall	25,000 00
Purchase price of site	29,469 00
Spare Stable and Supply Store house in rear of the Adelaide Street Fire Hall	8,000 00
Purchase of Site and erection of Fire Hall, Earlscourt	25,000 00

BRIDGES, ROADS AND PAVEMENTS.

Ottawa, Ont.—The Federal Government have inserted an item of $956,000 in the estimates to be used for the purpose of bridge building and calls for aid in the construction of the following works:—

Bridge Subsidies.

To the Vancouver, Westminster and Yukon Railway Company. From a bridge across Burrard Inlet, not exceeding $350,000.

To the Canadian Pacific Railway, for a bridge over the Saskatchewan at Outlook, not exceeding $115,000.

To the Kettle Valley Railway Company, for a bridge over the Fraser River, near Hope, not exceeding $250,000.

To the Caribou, Barkerville and Willow River Railway Company, for twenty bridges over the Willow River, not exceeding $95,000.

To the Grand Trunk Pacific Company, for a bridge over the Assiniboine, at Brandon, not exceeding $20,000.

Saskatoon, Sask. — The Railway Board, which recently held a sitting at this point, were asked to order the construction of a steel span bridge to replace the structure at present used by the Canadian Northern Railway.

St. Catharines, Ont.—The municipal council have given notice of their intention to pave several of the city streets and highways. The materials are bitulithic and vitrified brick and the estimated cost amounts to $43,000.

St. Catharines, Ont.—Two bridges in the vicinity of this city were badly damaged by ice during the recent thaw. They are in Lount Township and cross the Twenty Mils Creek.

Toronto, Ont.—The municipal council are considering the erection of the following bridges:—

Crawford Street, reinforced concrete arch with girder span approaches	$29,450 00
Strachan Avenue, two steel plate girder spans, concrete floor, Class A, exclusive of land damages	58,200 00
Cattle Market, steel lattice girder bridge on steel bench and steel approach ramps	14,900 00
Riverdale Foot Bridges, raising river span and adding two new spans over railway tracks	13,000 00
Gerrard Street Bridge, new bridge and river span—	
If of steel	151,800 00
If of concrete	200,000 00

CITY ENGINEERSHIP VACANCY.

Mr. J. Hutcheon has resigned his position as City Engineer of Guelph. The advertisement calling for applicants for the position will be found in this issue of The Canadian Engineer.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16115—March 2—Rescinding Order No. 13818 of May 31st, 1911, and authorizing city of Toronto to maintain wires across tracks of C.P.R. and G.T.R. and over wires of G.N.W. Tel. Co., to pumping station at foot of John Street, Toronto, Ont.

16116—March 13—Disallowing Tariff No. 1300 of Boston & Maine Railway re rates on granite from Beebe Jct., Que., to Montreal, Ottawa and Toronto and other points; complaint of the Stanstead Granite Quarries Co., Limited.

16117—March 14—Substituting plan "A" for plans filed for transfer tracks between C.P.R. and C.N.R. at Carberry, Man., and approved by Order No. 16035 of February 27th, 1912.

16118—16119—March 13—Relieving C.P.R. from erecting fences along its right of way on its Kimberly and Crow's Nest subdivision, in Provinces of Manitoba and Alberta, and British Columbia.

16120—March 13—Approving revised location of C.P.R. Moose Jaw southwesterly branch from mileage 0 to mileage 35.59 and location of same branch from mileage 35.59 to 37.85.

16121—March 14—Amending Order 16065 of March 6, 1912, re swing bridge of G.T.R. over Lachine Canal, Montreal, Que.

16122—March 14—Amending Order 16095 of March 7, 1912, by striking out words "County of Simcoe" and inserting "Twp. of Sidney."

16123—March 14—Authorizing C.P.R. to construct three spurs for St. Mary's Portland Cement Co., Ltd., Twp. of Blanchard, Ct. Perth, Ont.

16124—16125—March 14—Approving location of C.N.O. Ry. station grounds at Fallowfield and Merivale, Twp. of Nepean, Ct. Carleton, Ont.

16126—16127—March 14—Approving location of C.P.R. station at Drake, Sask., and plan of station at Dysart, Ont.

16128—March 15—Relieving C.P.R. from erecting fences on its Cranbrook subdivision, B.C. division.

16129—March 15—Authorizing G.T.R. to construct temporary bridge across Beauharnois Canal, at mile post 48.58 on its 13th dist., Ottawa division.

16130—March 14—Relieving G.T.R. from further protection of crossing fourth east of London city limits, Ontario.

16131—March 13—Directing G.N.R. to erect and maintain adequate and suitable fences from mile post 63 to 77; by 1st June, 1912, under penalty of ten dollars per day.

16132—March 15—Authorizing Pere Marquette Ry. to issue transportation to H. G. Shufelt, ice car inspector, of Dept. of Agriculture of Canada.

16133—March 15—Authorizing B.C. Electric Ry. to cross with its tracks of Esquimalt & Nanaimo Ry. near Russell station, B.C. Half interlocking plant to be installed.

16134—March 15—Approving plan of interlocking and derailing apparatus to be installed by C.P.R. at Batiscan River Bridge, on its Quebec subdivision.

Volume 22. Toronto, April 4, 1912

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An Engineering Weekly

WATERPROOFING CONCRETE STRUCTURES*

By C. A. HAGGANDER.

One of the hardest problems presented in connection with the construction of the concrete subway track elevation of the Chicago, Burlington & Quincy in Chicago is the waterproofing. These subways are constructed with concrete slabs or girders 7 ft. wide, built away from the work, resting on concrete abutments at the street lines and on concrete columns and cross girders at the curb lines and centre line of street. There is a joint between the slabs longitudinally across the bridge, also one over each cross girder and one at the bridge seat on top of the abutment. The slabs over the strees are 2 ft. 9 in. thick over the street girder, and 2 ft. 6 in. thick over the curb cross girder. The slabs over the sidewalk are 1 ft. 5½ in. thick over the curb cross girder and 1 ft. 2½ in. thick over the bridge seat.

The first waterproofing was done in 1906. The most natural method seemed to be the closing of the joints. In order to do this the first slabs were built with the sides offset as shown in Fig. 1. The open space between them after they were set was ¼ in. at the lower part and 1¼ in. at the upper part. A board was put under the joint where the bridge seats did not prevent the mortar from leaking through and the ¼-in. space was filled with cement grout to within 1½ in. of the offset. The next 3 in. was calked with oakum soaked with an asphaltic compound. The rest of the opening was filled with cement grout and over the entire joint were placed three layers of felt painted with this compound.

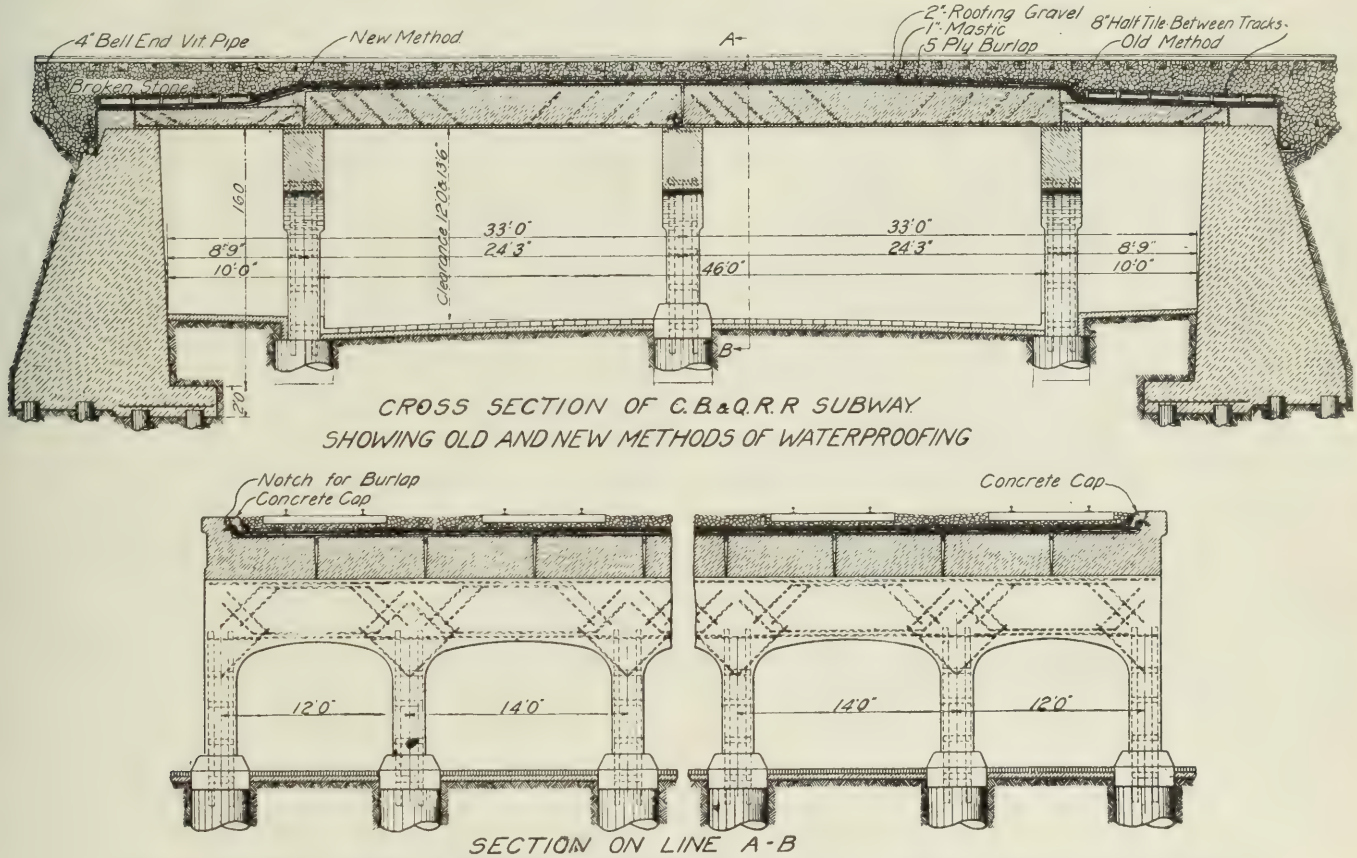

Fig. 8. Standard Method of Waterproofing Subways; C. B. & Q. Track Elevation Work, Chicago.

This method was not effective, the subways leaking very badly. It did not prevent the water behind the abutment from running through the mortar joint down the face, and the joints cracked open, letting the water through. It was thought best to fill the joints with some elastic material and six schemes were tried as shown in Figs. 2 to 7 inclusive. They consist of different arrangements of oakum, cement grout, tar or some asphaltic compound and sand. In every case the bottom of the crack was calked with oakum to prevent having to use boards under the joints. None of the methods were even partly successful until the sixth was tried.

* The Armour Engineer, January, 1912.

This one failed when the tar leaked out through the oakum, but this was prevented to a great extent by the use of sand above the oakum. At first the joints were water tight, but the jar and slight working about of the slabs loosened the oakum, letting the sand and tar escape. The joint at the abutment also leaked very badly. In addition to this the water found its way through two of the slabs themselves.

These methods had been tried during 1906 and 1707, and in 1908 it was thought best to waterproof the whole surface of the bridge and to aid the water in running off by a system of drain pipes.

The method shown on the right-hand side of Fig. 8 was the one adopted. The slabs were built with a ½-in. batter on the sides instead of with an offset so that they could be

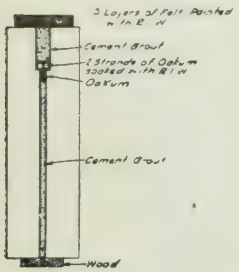

FIG. 1

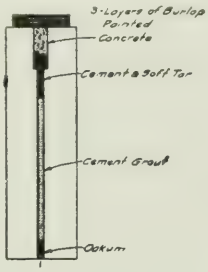

FIG. 2

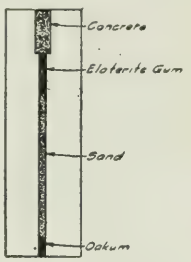

FIG. 3

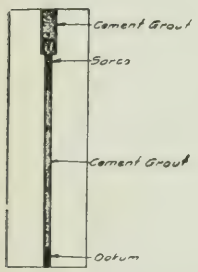

FIG. 4

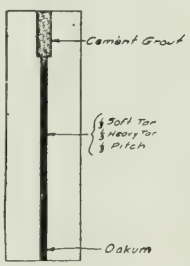

FIG 5

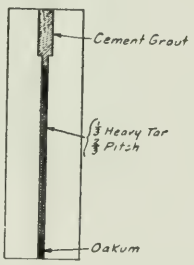

FIG 6

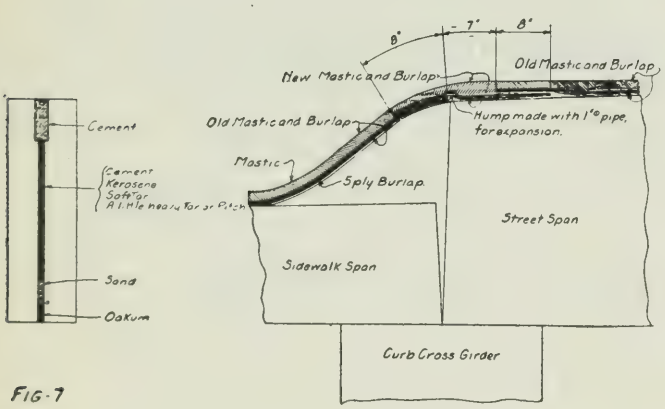

FIG. 7

FIG. 9

calked from above. After calking the cracks with oakum they were filled with cement grout. The vertical offset of 12½ in. over the curb cross girder was rounded off by a fillet of concrete. The abutment back of the bridge seat was built up to the level of the top of the sidewalk slab. The lifting stirrups or hook bolts by means of which the slabs were placed were cut off at the top of the concrete and the surface of the bridge swept clean. As a rule only one track or a width of 14 ft. could be waterproofed at one time because of operating conditions and the fact that the force used was of such size that this was one day's work. A strip about 4 ft. wide was mopped with a coat of asphalt which had been heated to the melting point. Four kinds of asphalt were used at different times, Sarco No. 6 and No. 651, melting point 160 deg., Barber Asphalt Company's positive deal "A," melting points 140 deg. Texaco and Warren Chemical Company's asphalt cement. On this was put a strip of 8-oz. open-mesh, first quality burlap, 42 in. wide. This came in 2,000-yd. bundles and was made into rolls coiled on a 1½-in. gas pipe 7 ft. long. It was applied by starting at one end of the bridge and rolling it across. A man followed the roll and swept out any wrinkles so as to give a smooth surface and bond it to the asphalt below. The top of this burlap and a strip of concrete about 15 in. wide on one side of it was then painted with hot asphalt and another layer of burlap laid, covering two-thirds of the first layer, the rest lapping over on the concrete. This burlap and the adjacent concrete were then painted and another strip laid covering one-third of the first and two-thirds of the second strip. In this way the burlap was made three-ply. Care had been taken that the temperature of the asphalt was not high enough to burn the burlap. A melting point of 160 deg. Fahrenheit gave the best results, as asphalt with a higher melting point burns the burlap and it becomes more brittle at low temperatures. After three-ply of burlap had been laid the whole surface was again mopped with asphalt and a protecting layer of mastic put on. This layer consisted of one part of asphalt and four parts of dry engine sand. The asphalt was heated to the melting point in one kettle and the engine sand heated over an iron plate. They were mixed and stirred in another kettle until of the right consistency, a slow fire under the kettle keeping the mixture plastic. This mastic was dipped into iron wheelbarrows, wheeled on broad runways laid on the burlap, dumped, and finished with wooden trowels to a thickness of 1 in. The top of this mastic was mopped with asphalt. This 1-in. layer was not intended to aid in waterproofing, but was put on to protect the burlap from the ballast and the track tools.

The drainage system consisted of inverted 8-in. half-tiles laid between each track leading from the hump over the curb cross girder to the back of the abutment. Back of the abutment and about 1 ft. below the bridge seat a board was placed on which rested another 8-in. half-tile. The end of the burlap rested in this and another 4-in. tile was laid in it. The tiling was given a slope of about 1 per cent. toward down-pipes. These down-pipes were 50 ft. apart and ran down the back of the abutment to the sidewalk level, then through it and under the sidewalk to the gutter. The mastic was protected by ¾ in. of roofing gravel to keep the sharp edges of the crushed stone ballast from cutting into it. The crushed stone ranged from ½ in. to 2½ in. and was used to allow free movement of the water through it.

It was not long, however, before the boards and tiling crushed down into the newly made fill, giving no means of escape for the water which ran off the bridge, causing it to back up above the level of the bridge seat and find its way down the face of the abutment. This was prevented by building the concrete so as to overhang the back of the abutment about 1 ft. and letting it run down the back about the same distance. The top of the abutment was painted with a heavy coat of tar paint before setting the slabs. This effectually sealed the joint. In all abutments built after this experience a notch was left in the top, as shown on the left-hand side of Fig. 8, in which to place the tile and prevent its crushing down.

After the first year's experience with this waterproofing, it was thought advisable to increase the thickness of burlap to five-ply. Many leaks had developed over the curb cross

girder due to the tearing of the burlap over the hump at the cross girder joint. This seemed to be caused by a slight expansion and contraction of the slabs and tendency of the waterproofing to travel down the slope of the hump due to the load of an engine above it. The crack which opened up was sometimes as wide as ¼ in. Some method of allowing for this had to be used so a 1-in. pipe was laid over the joint, the burlap put on in the regular way, the pipe withdrawn, and the mastic applied. This scheme was used on all work during the year 1909 and thereafter. Another precaution was taken by putting a flatter slope on the hump, the concrete being run out with about 3 ft. 6 in., so that the tendency of the waterproofing to slide down was diminished. The bridges waterproofed during 1909 are almost devoid of leaks.

The bridges which were waterproofed by filling the joints in 1906 and 1907 have since been waterproofed by the latter method. Those which were waterproofed during 1908 developed leaks where the waterproofing cracked and repair work was started during the fall of 1911. In this repair work the mastic was chipped off for a distance of 8 in. each side of the crack. The burlap was cut away from the crack to the edge of the mastic on the street slab. A 1-in. pipe was then laid over the joint and the mastic and the burlap was cut away from the crack to the edge of the mastic on the street slab. A 1-in. pipe was then laid over the joint and the mastic and the burlap on the street slab lifted up so that a new strip of burlap could be inserted under it. It was lapped under about 9 in. and then laid over the old burlap on the slope. Five-ply were laid, each painted with asphalt, the pipe withdrawn (thus allowing for expansion), and new mastic put on.

Records have been kept of the dates when different portions of the bridges were waterproofed. This repair work has shown that during the cold weather the asphalt that is applied to the cold concrete becomes chilled and does not penetrate the burlap which is laid on it. If the weather was very cold even the coat which was mopped on this first layer of burlap did not penetrate it, due to the fact that the cold concrete had chilled it. The second layer of burlap seemed to have been pretty well saturated in all cases, while the third layer was thoroughly saturated. In waterproofing which was laid during warm weather all of the burlap was in a good state of preservation, having been well saturated with the asphalt. The mastic seemed to protect the burlap very well, although in some cases track tools had penetrated it, causing leaks. The smaller sizes of crushed stone of about ½ in. did not penetrate the mastic as much as the larger sizes on account of the more uniform bearing.

The average force used on this work consisted of:

1 foreman	..... at	$.33	per hour.
3 finishers	..... at	.25	per hour.
1 kettleman	..... at	.27½	per hour.
8 laborers	..... at	.20	per hour.

These men waterproofed a bridge 14 ft. wide and 75 ft. long, or 1,050 sq. ft. per ten-hour day. The average cost of the latter waterproofing was a little less than 14 cents per sq. ft. for the burlap and the mastic, not counting the concreting over the hump and bridge seat and the filling of the joints with mortar. This work was done by another gang the day previous to the waterproofing. It added about three cents per sq. ft. to the cost, making a total of 17 cents.

This work was done under the direction of C. H. Cartlidge, bridge engineer, and L. J. Hotchkiss, assistant bridge engineer, and was directly in charge of F. H. Cramer, by whom much of the material in this article was furnished.

SOME METHODS OF PREVENTING DUST ON MACADAM ROADS.*

By John F. Icke, City Engineer, Madison.

A macadam road, as we all know, is made of crushed stone of varying sizes, held in place by filling the interstices with smaller stone, stone dust, or other suitable material as a binder. In the ordinary water bound macadam a cementing action takes place between the crushed stone and the dust used as a binder, the degree of this cementing action depending upon the material used as crushed stone and the material used as a binder.

The harder the rock, the less able it is to absorb moisture, and the more difficult it is to bind. For this reason the granites are more difficult to bind than the limestones when used as a road material.

In order to keep macadam street in good condition it must receive sufficient traffic to furnish more or less dust, and moisture must be provided to aid in keeping the stone cemented. If a sufficient amount of moisture is not present then the road will ravel and will be rapidly destroyed, especially if very much automobile traffic passes over the road:

In order to supply the necessary moisture the method known to all of us of applying water with a sprinkling wagon has been used almost exclusively in the past. The water so applied furnishes the moisture which is absolutely necessary to keep the macadam well bound, and also acts as a dust layer, or dust preventative.

Many objections to the use of water as a dust preventative may, however, be urged. If the water is applied in just the right quantity to lay the dust, but not in quantities enough to make the road surface unnecessarily muddy, then the service may be considered fairly satisfactory. The difficulty lies, however, in the almost impossible task of having the water applied often enough, and in quantities sufficient only to keep the surface moist.

Another objection to the use of water is on account of the injurious effect upon the road material that the frequent application of water has. Any slight depression in the surface of the road will collect and hold water, which will soften up the road surface and hasten the formation of still greater depressions. Still another objection exists in case the supply of water is inadequate. The demand upon the waterworks system is usually already great at that season of the year when the sprinkling of the streets is most urgent and in many cases the heavy demand of the sprinklers seriously interferes with the pressure throughout the system.

For some years past engineers and others interestel in road work have been experimenting with various materials and methods of application, designed as a substitute for water as a dust layer. The use of tar or asphaltic oil applied to the surface of the road, or of tar or asphalt as a binder for the upper two or three inches of th eroad surface is now good practice in many localities.

The application of tar or asphaltic oil on the surface of the road is generally spoken of as surface treatment. The writer's experience with the use of tar in the surface treatment of macadam streets dates back to the year 1908, when the first trial was made. The material used was a prepared tar, known as Tarvia A, made by the Barrett Manufacturing Company.

The street in question was one built of crushed limestone in 1897. The surface was in ideal condition, with very

* Extract paper read at 1912 meeting Engineering Society of Wisconsin.

few depressions or irregularities The preliminary treatment of the road surface before applying the tar consisted in thoroughly sweeping the street surface to remove as much of the dust as possible. The consistency of the tar was such as to make it necessary to heat it before it could be applied. Application was by means of sprinkling cans with broadened nozzles. Approximately one-half gallon of tar was applied per square yard of surface. The surface of the tar was covered with a thin layer of coarse limestone screenings approximately one-quarter inch in diameter, from which practically all the dust had been removed. The street was rolled with a fifteen-ton roller and was thrown open to traffic as soon as possible thereafter. After a short time, and after the excess of screenings had been worn away, the street resembled, in many respects, a sheet asphalt pavement. After the lapse of two years a second treatment was given, similar in all respects to the first, except that the quantity of tar per square yard was about one-third of a gallon. This second treatment was given primarily to cover the individual stones which projected above the general surface of the pavement and were thus not thoroughly covered by the first treatment. Several excavations made in the street since the last treatment show that the tar penetrated the surface of the road from three-quarters of an inch to

Tarviated Road in Madison, Wisconsin.

one inch, and thoroughly bound the surface. How soon it will be necessary to again apply the tar it is impossible to tell; however, it is safe to say it will not be necessary to apply another treatment for at least three years, and possibly not for five or six. The above mentioned treatment has practically eliminated the formation of dust caused by the breaking down of the stone under traffic. The street is, however, not dustless, as more or less dust is brought upon it from traffic and other outside sources, and it has been found advisable to give the street more or less sprinkling with water to keep down the small amount of dust which does accumulate on the street from the sources mentioned above. The street surface is so well bound that any ordinary rain will free the surface from dust as though it were an asphalt pavement. One objection to the above mentioned treatment is that it leaves the street slippery at those times when, due to weather conditions, other pavements like asphalt are also slippery.

The cost of the first treatment was 7 cents per square yard. In this cost is included all the items which should enter, namely, the cost of cleaning the street, the cost of the tar, of heating and applying it, the cost of the screenings and applying them, and the cost of rolling. The second treatment cost 4 cents per square yard, as the quantity of tar applied per square yard was less.

In addition to applying the heavy tar mentioned above a lighter tar (Tarvia B) requiring no heating before applying, has been used with considerable success. This tar is sufficiently fluid, under ordinary temperature, to run freely from the tank cars in which it is shipped. Before applying the tar the road surface must be cleaned of all dirt so as to expose the stone surface. The cleaner the surface of the street the better will the result be in the end. If any cakes of dirt or screenings are allowed to remain on the surface then the tar will not penetrate into the macadam, but will instead be absorbed by the layer of dirt or screenings. The first heavy rain will simply loosen the dirt layer and the street will in consequence become muddy. The street may be swept either with a rotary street sweeper or with push brooms. The former method is the more economical, but is somewhat objectionable on the part of the public on account of the raising of dust while the sweeping is being done. The raising of a dust while sweeping may be lessened somewhat by sprinkling lightly with water previous to sweeping.

The tar is hauled from the tank cars to the street in wagons equipped with a sprinkling attachment attached to the rear of the wagon. Several such attachments are on the market, the general principle of all being the same. Suitable regulating valves are provided on the attachment which makes it possible to gauge the quantity of tar to be applied. In practice about one-third of a gallon of tar is applied per square yard of street surface.

The tar, especially during warm weather, penetrates into the surface of the macadam sufficiently at the end of from six to twelve hours to enable the street to be thrown open to traffic. The efficiency of the tar as a dust preventative lies in the fact that it penetrates the surface of the street from one-fourth to one-half inch and firmly binds the stone in place.

The cost of the cold tar application described above is about 1 9/10 cents per square yard. In order to get the best results a second application of tar should follow the next season after the first application. These two applications will then be sufficient for the two or three following seasons.

AN OUTCOME OF THE GREAT BRITISH COAL STRIKE.

Following the distress of the recent coal strike in Great Britain, serious attention has of late been given to the immense deposits of peat in Ireland and the best method for their economical use.

The methods of preparing peat for fuel are very primitive and would have to be changed completely to make peat fuel a real competitor with coal. An attempt was made some years ago to make turf briquettes, but the scheme, though it promised well, did not turn out as successfully as was expected and the company failed. The moisture was squeezed out of the peat by compression and the briquettes when fresh seemed to be just the thing that was wanted, but whatever defect there was in the preparation of them they were not able to stand the knocking about they got in the railroad wagons and canal boats.

The problem of making peat briquettes that can travel by train without falling to pieces has, however, since been solved in Sweden and in other countries, and this fact has given encouragement to Irishmen to take the matter up again. The coal strike has brought the question within the range of practical things as nothing else could have done.

AIR LIFT PUMP—ITS ADVANTAGES AND DISADVANTAGES.*

The essential structural features of the air lift pump are exceptionally simple and few in number, and this fact constitutes one of its principal advantages. In its simplest form, as shown in Fig. 1a, it consists of a pipe for the discharge of the water and a smaller pipe for conveying compressed air to it at a point near its lower end.

The Eduction Pipe.—The discharge pipe is designated by various writers as the eduction pipe, lift tube, lift pipe, and rising main. It should not touch the bottom of the well or reservoir from which it is to pump, but should be elevated above it, so as freely to admit the water or other liquid through its lower open end. This end of the pipe should, however, be submerged below the liquid surface a distance which, the Wisconsin experiments indicate, should be greater than the height above the water surface to which the liquid is lifted. This latter distance technically is called the lift of the pump. The distance from the water surface down to the point of admission of the air into the eduction pipe is known as the submergence of the pump. Submergence generally is expressed as a percentage of the total length of the pump, measured from the point of air inlet to the point of discharge. The discharge should be free into a reservoir at atmospheric pressure. Submergence and lift should be measured from the elevation of the water as it stands under working conditions rather than under static conditions.

The Foot-Piece.—In most air lift pumps the compressed air from the air pipe enters the eduction pipe through a casting designed to cause the air to enter in a special manner. The casting used for such a purpose technically is called a foot-piece.

Frizell's and Pohle's foot-pieces are cited as examples in design. In the former the foot-piece is an hour-glass-shaped, perforated casting, so designed for the express purpose of admitting the air in small bubbles. In the latter type the exit end of the air pipe is enlarged by bevelling off the inner edge thereof, in order to permit the free delivery of the air in mass or bulk, and thus to avoid the formation of air bubbles.

Quite a large number of different foot-pieces have been devised and patented, and, in most cases, extravagant claims have been made for them as regards their effect in increasing efficiency of the pump.

The Wisconsin experiments indicate that changes in the form of the foot-piece have little if any effect on the efficiency and capacity of the pump, other than the effect due to the amount of obstruction of the water passages; a factor which differs in the various types.

Tail-Piece.—Most forms of foot-piece are arranged for the attachment of a pipe on to their lower ends, thus extending the eduction pipe some distance below the point of air admission, for the purpose of preventing the escape of compressed air from the bottom of the eduction pipe. The pipe used for such an extension is termed a tail-piece. The tail-piece is often made a larger size of pipe than is the remainder of the eduction pipe. The length and size to be used for a tail-piece are problematical.

A number of distinct types of air lift pump have been produced through the various methods that have been devised for piping the wells. The methods in most frequent use are illustrated in Figs. 1 and 2 and are described below.

Side Inlet Pump.—The side inlet pump, in which the air pipe is on the outside of the discharge pipe, is shown at (a) in Fig. 1. The air pipe is connected to the bottom of the eduction pipe by means of standard fittings, special castings, or one of the various patented foot-pieces. This method is used when the well is large enough to admit of the air and water pipes being placed side by side from top to bottom and is probably the most economical of the systems shown.

Annular Air Tube Pump.—Fig 1 (b) shows the annular air tube pump in which the well top is sealed and the air passes down through the annular space between the discharge pipe and the air pipe or well casing.

Many annular tube pumps have been built with no foot-piece or opening in the side of the pipe. In such pumps the air forces the water level in the well down until the bottom of the discharge pipe is uncovered. Air then enters the discharge pipe and the pressure in the annular space is lowered. This causes the fluid to rise again in the air space and discharge pipe until the pressures balance and then the operation is repeated. This causes the water in the well approaching the bottom of the eduction pipe to surge more violently than it would if it were allowed to rise in the well around the eduction pipe to its normal height, as it does in the side inlet system. It is claimed for pumps built in this way that this surging promotes the entrance of the water and air into the eduction pipe in a manner conducive of high efficiency.

Central Air Tube Pump.—Fig. 1 (c) shows the central air tube pump which uses the well casing as the discharge pipe, and introduces the air through a small pipe usually fitted with some special device or foot-piece attached at the bottom through which the air escapes. Usually a number of small holes are drilled, or a number of slits are cut into the lower joint of the pipe and the end plugged. An objection to this method is that when the well is cased for only a portion of the distance, the air and water may escape out of the well into fissures in the rock. The hydraulic radius of the water passage in the discharge pipe is reduced by the air pipe, which increases the fractional losses and so diminishes the efficiency, but in this method of piping the entire cross-section of the well, less the area of the pipe, is available for use as a discharging pipe; so a well piped in this way will have a greater theoretical capacity than wells of the same size piped by the other methods; notwithstanding the obstruction caused by the central air pipe. This fact is shown by the following comparison of the three methods. Assuming in each case that the wells are 6 ins. in diameter, the largest eduction pipe which can be got into the well with a 1-in. air pipe beside it, is 3⅛ ins. in diameter, while the annular tube method of piping a 4½-in. eduction pipe can be accommodated. In the central tube system it is assumed that a 1½-in. air pipe is used with the 6-in. casing serving as the eduction pipe. It may be noted from Table I. that the hydraulic radius of the central air tube pump is less than that of the annular tube pump, but the net area of the former is nearly twice as large as that of the latter. The discharge through a pipe under a given head is proportional to the product of the area and the square root of the hydraulic radius of the pipe. This product has been calculated and tabulated in the last column and shows the relative capacities of the wells piped according to the three different methods, assuming the value of the co-efficient of pipe friction and slip to be the same in all three cases.

*Abstract of Bulletin No. 450, University of Wisconsin, by G. J. Davis and C. R. Weidner of the Department of Hydraulic Engineering

Table I.—Hydraulic Properties of Three Types of Air Lift Pump.

TYPE	Nominal size of wells.	Nominal size of eduction pipe.	Nominal size of air pipe.	Approx. net area of eduction pipe.	Approx. wetted perimeter	Hydraulic radius.	Discharge function*
	Ins.	Ins.	Ins.	Ins.	Sq. ins.	Ins.	Ins.
Side inlet pump	6	3½	1	9.89	11.15	0.89	9.33
Annular tube pump..	6	4½	6	15.96	14.62	1.13	16.9
Central air tube pump	6	6	1½	26.05	25.02	1.04	26.5

* Area of eduction pipe in square feet multiplied by the square root of the hydraulic radius.

Combination Pump.—Fig. 1 (d) shows a combination of the annular air tube and central air tube methods of piping. It is evident that the hydrostatic head in the well cannot be greater than that due to the ground water to permit of continuous operation. Therefore, no special advantage is to be gained in introducing compressed air above the water surface in the well, unless the increased surging, due to the less depth of water on the outside of the eduction pipe, might affect the size of bubbles of air admitted. The results of

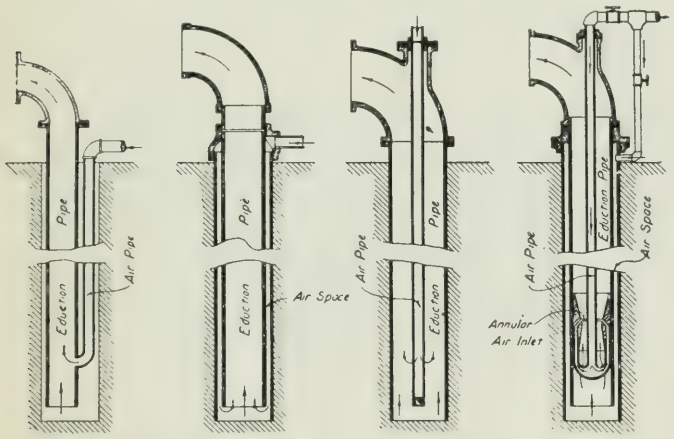

Fig. 1.—Different Methods of Piping Wells for Air Lift Pumping.

the Wisconsin experiments show that with the well piped according to the side inlet method, using a Harris Air Pump Company's foot-piece, there was no appreciable difference when compressed air was introduced above the water surface in the well and when the well was open to atmospheric pressure, the percentage of submergence and lift being the same in both cases.

Multiple Air Lift Pump.—When the lift is very high and the proper submergence difficult to obtain, the arrangement shown by Fig. 2 may be used where the cross-section of the well permits of its use. This arrangement employs a series of successive lifts and it is claimed that it works more economically than when the water is raised in a single lift. The cross-sectional area of the ordinary deep well will not permit of such an arrangement, but it may be used to advantage in a mine shaft.

Return Air Pump.—In rising through the eduction pipe there is a transfer of heat between the air and the water; the temperature of the two being practically equal at the point of discharge. Therefore, where the air lift is being used to pump from underground supplies, the temperature of the air issuing from the discharge pipe will be cooler than the atmosphere during the warm months of the year. For each five degrees fall in temperature of the free air entering the compressor, a saving of about 1 per cent. in the expenditure of energy used in doing the work of compression may be effected. Hence, where the wells are situated in close proximity to the power house, considerable economy may be effected by connecting the air inlet of the air cylinder of the compressor with the top of the well casing head. An air separator used for this purpose consists of a cylindrical drum about 18 ins. in diameter and 8 or 10 ft. long, attached to the casing head from the side of which the discharge from the well passes out. From the top of the cylindrical drum the air is piped to the compressor, as shown in Fig. 3. The return-air method may be used with any of the types illustrated. The air separator described above is useful also where it is desired to pump to points situated some distance from the well.

Diverging Outlet Pump.—When the eduction pipe is of uniform diameter throughout, the velocity of discharge is comparatively high, and there is considerable energy lost. To conserve this kinetic energy of the water an eduction pipe which increased in diameter towards the top has been used. In this form of eduction pipe as the compressed air expands in rising the velocity is not greatly increased. This device could be used with any type of foot-piece and any method of piping. A few experiments by the authors of the bulletin indicate that a considerable saving may be effected by the use of a diverging outlet of proper design.

The Plant.—An air lift pumping plant comprises the motive power, an air compressor, an air receiver, and an air pipe leading to one or more pumps such as have been described in the preceding paragraphs.

Fig. 4 serves to illustrate, in a general way, the machinery and other essential apparatus.

The compressor and receiver should be located where the expense of installing and operating the plant will be the least. They often are situated a considerable distance from the wells. The power used to drive the compressor may be either steam, electric, water or internal combustion engines.

The Compressor.—The type of compressor installed will depend on the pressure required to pump the wells, the nature and amount of power available for compressing the air, and the number and size of the wells. Where the pressure required is small and the quantity to be compressed not very large, the ordinary straight line or duplex compressor may be used. Where high air pressures are necessary economy demands the cross compound type fitted with an intercooler.

The Receiver.—The receiver is used to store and equalize the air pressure. It acts in much the same way as the air chamber on a force main and reduces the effects of the pulsations of the compressor. It also acts as a separator to catch the water and oil which are carried by the air. It is quite necessary to provide some kind of separator for this purpose to prevent the air pipes becoming clogged, and where a foot-piece with small air openings is used it is especially desirable to have the air free from any clogging material. The air receiver is usually built of boiler iron and designed so as to permit a steady flow of air to the well. The air from the compressor passes down from the top of the receiver through a pipe and discharges beneath the surface of some water which is usually kept in it. The outlet pipe for the air is located near the top of the receiver, and a drain is provided at the bottom to carry away the oil and water.

The Air Line.—From the receiver the main line runs to the wheels. The piping to the wells should be arranged to avoid unnecessary valves, elbows and bends, as these reduce the efficiency of the plant. The same precaution should also be taken in the design of the water pipes. A valve

should be placed on the air main in the power house so that the wells may be controlled from a central point. It is desirable to place a regulating and a stop valve at each well so that after the proper amount of air has been adjusted to the conditions of lift, submergence, etc., at the well, it will not be necessary to disturb the adjustment in order to shut down the well.

In the bulletin the discussion is confined to the air lift pump alone, leaving out of consideration the efficiency of the air transmission pipes, compressors and other appurtenances, which have an important bearing on the desirability of installing air lift pumping plants, but the consideration of which is beyond the scope of the bulletin.

Disadvantages of the Air Lift Pump.—The air lift pump, in common with every other device, has a number of disadvantages, the principal ones being its low efficiency, the great depth of submergence required and its poor adaptability to conditions requiring the discharge to be conveyed great horizontal distances.

Low Efficiency.—The most serious of the above-mentioned disadvantages is the low hydraulic efficiency of the pump. The pump is generally credited with efficiencies of only 25 to 33 per cent., but notwithstanding the low efficiency of the pump itself, the entire air lift pumping plant in some cases develops a duty which compares favorably with other systems of pumping.

Great Depth of Submergence.—A single air lift pump cannot be used in a shallow well or reservoir except to raise the liquid a very small distance, owing to the high percentage of the total length of the pump which must be submerged to give good efficiencies. This fact limits the field of the air lift pump principally to deep well pumping. The multiple stage previously described overcomes the difficulty, but probably at the cost of reduced efficiency.

Limited Horizontal Pumping.—Several plants have been installed where the air lift was used to pump the water a considerable horizontal distance after it had been raised to the surface of the ground, but such plants are not considered efficient. The air in passing through the horizontal or even an inclined pipe, is not likely to be evenly distributed throughout the cross-section of the pipe, but is likely to pass along under the upper side, allowing a large space in the lower portion of the pipe for the water to slip back past the bubble. In a horizontal pipe the air cannot exert any buoyant effort to aid in discharging the water, and its expansive force, which might be used in overcoming pipe friction is not likely to be effective on account of the serious amount of slip which occurs under these conditions. Where it is desired to convey the water to a point distant horizontally from the well, the eduction pipe should be carried vertically above the well a height equal to the friction head of the water in the horizontal conductor, and at its top it should be fitted with an air separator, such as the one previously described. From the separator the water would flow by gravity to the desired point.

Aeration.—The thorough aeration of the water pumped is generally regarded as an advantage, but under some circumstances it is a disadvantage. It doubtless promotes the rusting and consequent destruction of the eduction pipe and in some cases causes a deposit of salts which clogs the water passages, especially in the foot-piece. The opinion has also been expressed that compressed air causes an excessive growth of algae. The bacterial content of water is somewhat increased by the air lift unless the air supply is filtered.

Advantages of the Air Lift Pump.—The air lift pump possesses many features which give it decided advantages over other types of pumps, when applied to certain conditions.

Large Capacity.—Its principal claim to superiority lies in its large capacity. When the conditions are suitable for its installation, an air lift pump will discharge more liquid from a well of small bore than will any other type of pump. This is due to the fact that almost the entire cross-sectional area of the well is available for the flow of liquid and the action is nearly continuous. The quantity that can be discharged by an air lift pump is only limited by the capacity of the well and the expense of pumping at unreasonably high rates; while deep well pumps, the majority of which are single acting, limit the discharge by the allowable piston speed, which usually does not exceed 100 ft. per minute. The air lift affords a ready means for testing the capacity of a well even if it is not to be permanently installed.

Low Maintenance Cost.—Owing to the simplicity of the pump the expense of maintenance of the plant is very low, and is due principally to the expenses in connection with the compressor. The operation of the air lift is exceedingly simple and the life of the pump is almost indefinite. Sometimes the air pipes and foot-pieces become clogged with the oil carried over from the compressor cylinders and in that case have to be removed and cleaned, but this rarely occurs, and when it does the cost is small compared with the cost of replacing a mechanical pump. The fact that there are absolutely no moving parts in the well makes the pump especially fitted for handling dirty or gritty water, sewage, mine water and acid or alkaline solutions in chemical or metallurgical works, or other corrosive liquids. Mechanical pumps suffer from fine sand in the water, which cuts the packing, plungers and valves in a short time and makes frequent repairs necessary. To repair such pumps they have to be stopped for a period of several days, resulting in a consequent waste of time and increase in expenses. Liquids that attack metals such as brine, sulphuric acid, etc., may be pumped by the air lift pump, because the pump and appurtenances may be replaced at a small expense and loss of time. The application of the air lift as a dredge pump has been tried and found successful, but it has not been extensively used for this purpose.

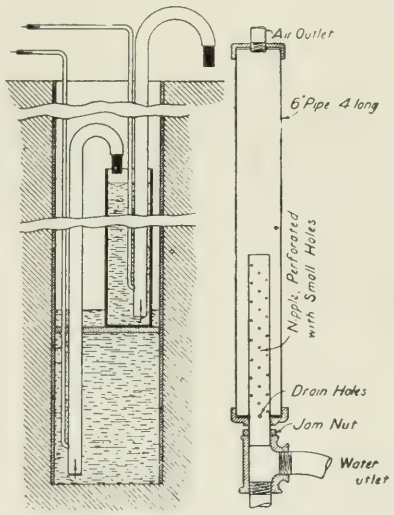

Fig. 2—Multiple Air Lift.
Fig. 3—Air Separator.

Low Operating Cost.—In places where the wells are scattered over a considerable area, or are remote from the power house, the air lift pump has an advantage over the steam-driven pump. In a deep well pump driven by steam each well must be equipped with a separate and working barrel, which entails heavy condensation losses through long steam supply pipes. The expense of attendance of a plant of this sort with its scattered pumping units is great. In

the air lift pump the transmission loss is much smaller and as no attendance at the well is required, they may be put in operation or controlled by a valve in the power house.

Not Affected by High Temperatures.—Fluids of different densities and temperatures may be handled to advantage by the air lift in cases where the use of other types of pumps would be prohibited. In the case of a hot liquid the air absorbs part of the heat of the liquid and hence is increased in volume, so that the discharge of liquid for the same expenditure of free air is greater with hot than with cold liquids. This results in a considerable gain in efficiency for the pump.

Aeration.—Where the water is to be used for a domestic supply and there are impurities in it such as iron, it has been noticed that the iron is oxidizd by the aeration of the water and the supply is thereby improved Aeration is especially advantageous in the pumping of sewage on account of the aid it gives in the oxidation of the impurities.

Reliability.—Air lift pumps are not liable to sudden stoppages or breakdowns.

The Wisconsin eyperiments were not made on actual wells, but the apparatus was designed to reproduce as nearly as possible the practical working conditions of the air lift pump.

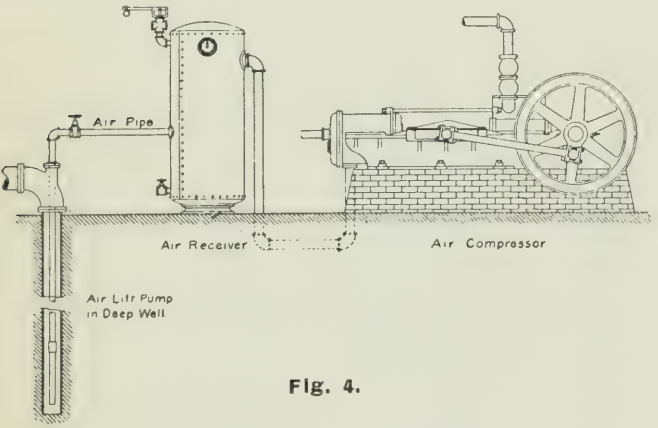

Fig. 4.

The experiments made by the writers were planned to determine, first, the effect on the discharge and efficiency of variations in the working conditions of the air lift pump, such as variations in submergence, lift and quantity of air used, and second, the effect on the discharge and efficiency of changes in the structural features of the pump. The bulletin contains the complete log of the experiments, arranged in tables and diagrams. The coefficients which were evaluated and applied to Lorenz's theory of the air lift are given. The conclusions reached by Messrs. Davis and Weidner are as follows:

Conclusions.—A comparison of the advantages and disadvantages of the air lift pump shows that there is a field of usefulness of sufficient magnitude to make it an important apparatus deserving of further theoretical and experimental study. From a study of the discussion and accompanying data given in the bulletin, ideas in regard to improvement in the design will no doubt be suggested to the designer or experimenter. However, a full realization of the complexity of the action must be appreciated, as also the number of variables which enter into the problem. In order to facilitate the study of results, the variables which may affect a particular type and size of pump are again given at this place. They are (1) percentage of submergence, (2) lift, (3) discharge, (4) volume of air, (5) pressure of air. The conclusions which may justifiably be deduced from the Wisconsin experiments are given below, and hold only for the particular type, size and length of pump on which the experiments were performed. The inference, however, may be drawn that these conclusions would hold for other types and sizes.

(1) The central air tube pump has the greatest theoretical capacity for a given size of well.

(2) The coefficient of pipe friction and slip decreases as the discharge increases, and decreases as the ratio of volume of air to volume of water increases.

(3 The coefficient of pipe friction and slip varies with the length of pump, but seems to be independent of the percentage of submergence and of the lift.

(4) The length of pump, the percentage of submergence, and therefore, the lift remaining constant, there is a definite quantity of air causing the maximum discharge. This quantity of air for maximum discharge, as also the ratio of volume of air to volume of water, differs for different percentages of submergence and lift, the length of the pump remaining constant.

(5) The length of pump remaining constant, the maximum output (e.g., foot gallons) occurs at about the same percentage of submergence for all rates of air consumption, being at from 61 to 65 per cent. for the pump used in the Wisconsin experiments. At other submergences the output varies as the ordinates of a parabola having vertical axis. Under these conditions the lift does not remain constant as the percentage of submergence varies.

(6) The length of pump and percentage of submergence remaining constant, and therefore constant lift, the efficiency increases as the input decreases; that is, the highest efficiencies are obtained at the lowest rates of pumping.

(7) By varying the percentage of submergence, and therefore the lift, the length of pump remaining constant, the maximum efficiency is obtained at approximately 63 per cent. submergence for all rates of input or discharge.

(8) The lift remaining constant, the efficiency increases as the percentage of submergence increases, for all rates of input and all practical percentage of submergence.

(9) With the same size and type of pump the percentage of submergence remaining constant, the efficiency increased as the lift increased for the small lifts experimented on; that is, up to about 24 ft. From a theoretical study, however, the indications are that a point will be reached from which the efficiency will decrease as the lift increases.

(10) Other conditions remaining constant, there is no advantage to be gained by introducing compressed air above the surface of the water in the well.

(11) The type of the foot-piece has very little effect on the efficiency of the pump, so long as the air is introduced in an efficient manner and the full cross sectional area of the education pipe is realized for the passage of the liquid. Anything in the shape of a nozzle to increase the kinetic energy of the air is detrimental.

(12) A diverging outlet which will conserve the kinetic energy of the velocity head increases the efficiency.

THE TRANS-AUSTRALIAN RAILWAY.

Full plans and complete specifications for the construction of the railway between Port Augusta in South Australia and Kalgoorlie in Western Australia have been prepared by the engineers of the Commonwealth government. The delay in making the plans available is said to be caused by important questions of policy—such as the gauge to be decided upon and the wages to be paid to laborers. It is understood that the construction will be carried on by day labor, but parts of the work may be done by contractors.

COST OF GIRDER AND SLAB CONCRETE HIGHWAY BRIDGES.*

By B. H. Piepmeier.

The purpose of this paper is not to discuss the practice of the Illinois Highway Commission in the design of through girder and slab types of concrete highway bridges, but to develop a ready means of ascertaining the approximate number of cubic yards of concrete in a completed structure of a known span, height of abutments and length of wings, as well as to develop a means of making preliminary estimates of the cost of completed structures without calculating the quantities in detail.

The bridge work of the commission requires a personal inspection of the bridge site with the local officials, and at this meeting the necessary data are obtained for the design of the bridge. Almost invariably the officials expect that an estimate of the cost of the proposed work be given them at this time. Consequently, it is desirable to be prepared to give an estimate of the proposed bridge that will closely approximate the one that is made from the detailed drawings. This is usually a somewhat difficult matter unless the time is taken to compute the number of cubic yards that will be in the bridge.

With the increased interest in concrete bridge work the past four or five years, it is needless to say that the commission has been called upon for engineering assistance more frequently each year, until to-day it is almost impossible to meet all the requests. For this reason a system of standards was devised and all computations tabulated. This greatly improved the office efficiency and made it possible to answer a large number of requests.

Again, in our office, it has been necessary to do considerable figuring to determine the best make up for a bridge. Frequently a series of small slabs on piers would sum up much cheaper than the larger spans, and vice versa. It is sometimes advisable to compare a steel bridge for the same site. With curves worked out by Mr. H. E. Bilger on the cost and the number of cubic yards in substructures for steel bridges, we are able to get a very accurate estimate of the cost of a steel bridge complete. It, therefore, became desirable that some ready means be devised for determining the approximate number of cubic yards in concrete slab and girder bridges, for both office and field use.

From the large number of computations we have made of various concrete bridges, it was thought possible that a complete tabulation of quantities or a system of curves could be worked out that would enable one to determine readily the contents of either the slab or the girder type of bridges. It is proposed, therefore, to correlate all computations and data on the flat top type of bridge, and to arrange it in a convenient form for both office and field use in determining the number of cubic yards in ordinary bridges, besides obtaining an approximate estimate of the cost. Before proceeding, however, it may be well first merely to outline in a general way the slab and the girder bridges as designed by the Illinois Highway Commission, and give a few dimensions that you may better understand the types of bridges under consideration.

Slab Bridges.—For reinforced abutments for slab bridges the main wall is made 12 inches thick from top to bottom, the steel reinforcing being placed on the stream side, and the percentage of steel increased as the height increases. The abutments rest on an 18-in. reinforced footing, which is made of sufficient size to allow but 3,000 lb. per square foot bearing on the foundation. When a soft foundation is encountered, this same size footing is usually sufficient to permit the proper spacing of the required number of piles.

The reinforced wings for slab bridges are of the standard cantilever type, the base being 33 per cent. of the total height. The wing wall proper is 12 in. thick for heights up to 16 ft. For greater heights the base of the wall increases in proportion to the height. Nearly all wings for this type of bridge have a drop of 18 in. to 5 ft. at the end to conform to the 2 to 1 slope on the sides of the road. I may say here that the cantilever type of wing for extreme heights has been found much more satisfactory than the buttress type, as the increased thickness at the base and the large percentage of steel does not equal the extra cost of forming necessary for the buttress type.

Reinforced concrete slab bridges are designed with various roadways, ranging from 16-ft. upward. The side rails usually average 8 in. thick and 3½ ft. high. On this type of bridge the slab and the side rails come flush with the back of the abutment walls. The top of the wings comes up along the outside of the rails to catch the side slope on the road. In determining the thickness of the slab, its entire dead load is considered, the load of the cushion wearing surface, and a 24-ton engine live load. Excluding temperature stress, the steel is figured at 12,000 lb. per square inch; the compressoin in the concrete is assumed at 800 lb. per square inch.

Girder Bridges.—For the reinforced abutments for girder bridges, the general type is the same as that for the slab bridges, with the exception that all abutment walls proper are 18 in. thick, and the width of base for the wings is 40 per cent. of the total height. The extra thickness in the abutments is for bearing of the girders. The extra width of base under the wings is for stability, as the wing walls are cut away from the abutment walls proper by a 1-in. partition to allow for expansion of the superstructure. They can, therefore, receive no support from the abutments, as is the case with wings on slab bridges. The wings on this type of bridge also come up on the sides of the girders and drop several feet at the ends to follow the general side slopes on the road.

The reinforced concrete girder superstructures are designed with roadways from 16 to 30 ft. The roadway usually required is 16 to 20 ft. The side girders average from 4 to 16 ft. in height, and 16 to 30 in. wide on the top. On the side girders there are heavy depressed panels to lighten the web and to give the proper appearance to the finished bridge. The floor slab and side girders on this type of bridge also extend to the back side of the abutment wall. The floor slab is designed to carry its own dead load, the cushion wearing surface and a 24-ton engine live load. The side girders are designed to carry the entire dead load of the superstructure, plus a live load of 125 lb. per square foot on the roadway, or a 24-ton engine, whichever gives the greater moment.

Abutment Diagram.—For the purpose of determining offhand the approximate yardage in a pair of reinforced concrete abutments for either slab or girder bridges, Fig. 1 has been prepared, and is applicable within the specific cases used. For abutments of slab bridges, 40 different designs were taken from the files of the commission, and the number of cubic yards in the two abutments of each design was plotted against H (R + 2W), where H is the distance from the finished roadway to the bottom of the footings, R is the clear roadway of the slab bridge, and W is the length of one wing measured on the stream side. R was taken as the clear roadway of the bridge, as this figure is always secured at the preliminary inspection of the bridge site. W, the length of the wing, can always be assumed in the field or

* A paper read before the Illinois Society of Engineers and Surveyors.

computed in the office, knowing first the general conditions of the bridge site.

It will be noticed that the number of cubic yards in the two abutments varies approximately as the height of the abutments; also, that the maximum deviation from the curve does not exceed 2 cu. yd., and more often it is less than 1 cu. yd. In fact, for heights of abutments up to about 16 ft., or where H (R + 2W) does not exceed 900, the quantities so plotted follow practically a straight line, and might be represented by the straight line formula, cubic yards = 0.09 [H (R + 2W)] — 1.37, which often is convenient when the curve sheet is not at hand.

For a particular bridge, suppose the distance from the crown of finished roadway to bed of stream is 10 ft., and the footing should be carried 4 ft. below bed of stream. Then H = 14 ft. Now assume the wings are each to be 13½ ft. long, and that the finished bridge will have a 16-ft. clear roadway. We have now H (R + 2W) = 600, the value to be read at the bottom of Fig. 1.

It will be seen by locating the point on the curve and going across to the left-hand side that there are about 53 cu. yd. in the two abutments. Where the quantity at the bottom of the figure exceeds 900, we readily see that the curve begins to rise above the straight line. This is expected, as abutments exceeding 16 ft. in height have the base of the wings spread to allow for the proper percentage of steel. This extra width of base is added to the back of the wing wall by a batter, the batter extending up from the footing 4 to 8 ft., according to the height of the wall. This batter does not extend to the top of the wall, as the drop at the end of the wing would increase its thickness at the end, and this does not give the best appearance to the finished bridge. The abutment walls remain 12 in. thick up to 21 ft. high, and from there on the thickness increases as the height. The slight variation from the curve in solving specific cases may be attributed to the difference in the angle of the wing with respect to the abutment, and the difference in width of footing for bearing. The more nearly the direction of the wing approaches a parallel with the centre line of the road, the higher will be the wing at the end, thereby increasing the number of cubic yards, but as the corner formed by the intersection of the abutment wall and wing is measured twice, these two quantities tend to compensate one another.

For the reinforced abutments on girder superstructures 25 designs were taken from the files of the commission, and the number of cubic yards in the two abutments plotted against H (R + 2W), the notation being the same as before.

It is to be noted here that the number of cubic yards is somewhat greater than the number of yards in the abutment for slab bridges. This is due to the extra thickness of the abutment walls proper, to give the desired bearing and the extra width of footings under the wings. It will be noted on this curve that some of the specific cases used had a wide variation from the mean. This can be attributed to the fact that some of the abutments had extremely long wings that were level on top and also the different length of spans requires a little different width of footing under abutments to take the required bearing. A curve of this kind could not take into account all of these conditions, and while several points fall several yards off the curve, the mean is close enough for the purpose that it is to meet.

For a particular case, take the same dimensions that were considered before; clear roadway, 16 ft.; height, 14 ft., and length of wings, 13½ ft. We now have 600 to read off at the bottom of Fig. 1. Getting the intersection with the curve for girder spans, we find that the two abutments contain 67 cu. yd. instead of 53 cu. yd. in case of the slab span, a difference of 14 cu. yd. in favor of the slab bridge. Fig. 1 then is a ready means of comparing the substructures of the two types of concrete bridges and to determine the approximate number of cubic yards in each.

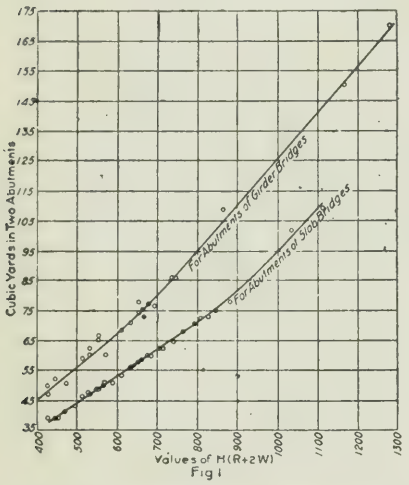

Fig 1

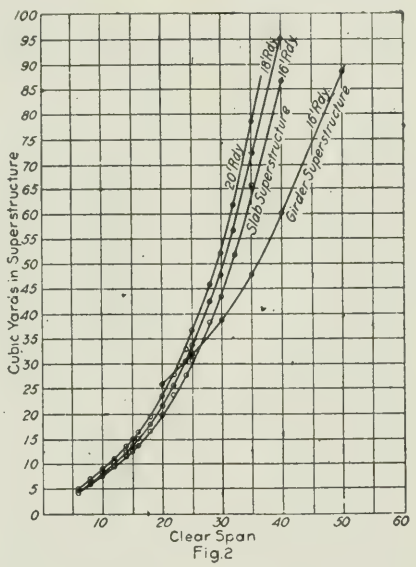

Fig.2

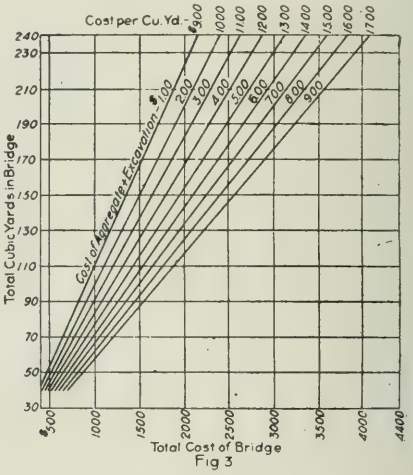

Fig 3

Diagrams for Determining the Approximate Cost of Through Girder and Slab Bridges.

Superstructure Diagram.—The next thing of importance is to determine the number of cubic yards in the superstructures of the two types of bridges. For this, Fig. 2 has been prepared, and is applicable for the flat top type of bridges up to 50 ft. in span. For slab superstructures 48 designs of different roadways and spans were taken from the files of the commission, and the total number of cubic yards in the superstructure was plotted against the clear span length, the curves drawn through the points having 16, 18 and 20 ft. roadway. The three curves will meet the requirements of the majority of highway bridges. Occasionally a special case arises, such as a skew or extra wide roadway, and then it is necessary to make special computations to determine the number of cubic yards.

For a special case, assume a bridge to have a 30-ft. clear span and 16-ft. roadway. We readily see the number of cubic yards to be about 43.2.

We may wish to consider for the same site the 30-ft. girder type with 16-ft. roadway. Here we see that the number of cubic yards is about 38.6, or a difference of 4.6 cu. yd. in favor of the girder superstructure. But you will notice for the same height substructure the difference in all cases is in favor of slab bridges. If it should happen that

for a single span the girder bridge and the slab bridge should have the same yardage, an advantage still rests with the slab type, as it has been found that contractors usually bid more favorable on this type. There is also another very important point in favor of the slab type. If for any reason there should be any defective material placed in the rail, or poor alignment in its construction. it may be torn down and replaced without disturbing the floor, even after the falsework has been taken down.

Cost Diagram.—Having found the expression that is the measure of the number of cubic yards in the abutments and superstructures of concrete slab and girder bridges, the next step is to combine the quantities with a unit price that we may determine the approximate cost of each type. For this purpose Fig. 3 has been prepared.

It has been found from the cost data of a large number of slab and girder type concrete bridges built under the supervision of the Illinois Highway Commission, that it is possible to get a very close figure on each individual item that goes to make up the cost of the bridge; first, the cost at the bridge site of sufficient cement to make 1 cu. yd. of 1:2½:4 concrete; second, the cost of the necessary lumber for forming 1 cu. yd.; third, the cost of reinforcing steel per cubic yard of concrete; fourth, the labor cost in mixing and placing 1 cu. yd. of concrete; fifth, the cost of sufficient aggregate to make 1 cu. yd. of concrete; sixth, the cost per cubic yard of concrete to make the necessary excavation to start the concrete of the footings. The two items that largely control the cost of a structure of this kind are the excavation and the necessary aggregate for the concrete. We find that the cost per cubic yard of concrete for cement, forms, reinforcing steel, and the mixing and placing, have narrow limits in their variation.

It therefore appears possible that some definite quantities may be fixed to the first four items and a curve plotted for the last two, combining them in such a way that the total cost may be readily determined after we have learned the number of cubic yards in the bridge.

The cost at the bridge site of sufficient cement to make 1 cu. yd. of concrete for a 1:2½:4 mixture may vary from $1.75 to $2.10. While the price of cement, the distance it has to be hauled, and the amount required for some aggregates, vary slightly, the extreme variation would not be over 20 cents per cubic yard from the average. From a general average of all cost data on this item, it would seem that we are probably safe in choosing for cement about $1.90 per cubic yard of concrete.

The cost of forms includes all the necessary falsework, bracing and form lumber for completing the bridge. While this item varies somewhat for different localities, and will vary again where the contractor can use some of his old lumber, it will fall between the limits of 75 cents and $2.50. Experience has shown that about $1.50 for the ordinary type of bridge is usually sufficient and might well be chosen for this cost curve.

The reinforcing steel varies from 50 lb. per cubic yard for substructures to 170 lb. per cubic yard for superstructures, or an average of about 110 lb. for the two combined. This steel delivered at the bridge site under ordinary conditions and bent ready for placing in the structure will cost about $2.10.

The item for mixing and placing concrete might vary from $1.50 per cubic yard for crushed rock concrete mixed by hand to possibly as low as 40 cents for gravel concrete mixed by machinery. This item should also provide for the necessary work in spading the concrete next to the form and securing the desired finish. In spite of the possible wide variation, we find the cost of this item varies but little from the fixed amount of $1.25. While all these quantities given above may seem somewhat in doubt as to their reliability, yet experience has determined that they are not far from the correct figures for normal conditions on the average bridge.

The item of excavation, which includes also cribbing, sheet piling, pumping, and all necessary work to start the concreting of the footings, has been found from the cost data on file to vary from 50 cents to $5 per cubic yard of total concrete in the bridge. The 50 cents per cubic yard is found only in some very favorable cases and on the smaller spans, where there is practically no cribbing, sheeting or pumping necessary. On the other hand, the cost of $5 per cubic yard of concrete is caused by a soft, seepy soil where cribbing, sheet piling and excessive pumping are necessary. Quite often the wide variation in the item for excavation is due to poor management on the part of the foreman in charge. This item, therefore, may vary considerably, but with experience with the excavation that is to be handled and with the type of bridge that is to be built, one is able to estimate this item sufficiently close for all practical purposes.

It will be seen that the cost of the aggregate delivered to the bridge site is the second item determining the price per cubic yard of concrete. Under the most favorable conditions with respect to location of a satisfactory aggregate supply, it would likely cost at least 50 cents per cubic yard to haul it to the mixing plant. On the other hand, the cost of aggregate at the bridge site might exceed $4 per cubic yard, as the structure may be isolated from a railroad station, and it may be necessary to ship in either gravel or crushed rock and sand, besides hauling it several miles into the country.

In the light of the wide range on these two items, Fig. 3 has been prepared to give the total cost of the bridge complete, including profit to the contractor under conditions where the cost of excavation, plus the cost of aggregate at the bridge site, might vary from $1 to $9.

For a specific case, we will assume that a concrete bridge has 120 cu. yd. of concrete. We will next investigate the condition of the foundation, and assume the cost for completing this part of the work, and express it as so much per cubic yard of concrete. We then approximate the cost of delivering at the bridge site the necessary aggregate to make 1 cu. yd. of concrete. For convenience let us say that these two quantities amount to $3 per cubic yard of concrete. Entering Fig. 3 with 120 cu. yd. at the left-hand side, and following this across to the $3 curve, or the $11 per cubic yard, which is the same thing, and then to the bottom of the figure, we find the cost of the bridge complete to be $1,300. The total cost per cubic yard of concrete is shown at the top for aid in determining the unit price.

From the figures heretofore given, we are able to determine approximately the number of cubic yards in either the slab or the through girder type of bridges, besides having a ready means of determining the probable cost. While the curves here developed apply only to the slab and through girder types of bridges, similar curves might readily be developed for the deck girder, the through girder floor beam type, or the arch, and would prove of equal service to the highway engineer, but their development is beyond the scope of this paper.

The foregoing is not intended to supply a substitute for engineering ability, but rather to furnish aid that will safely direct the engineer who will interpret with judgment and experience.

BRITISH COLUMBIA'S FOREST WEALTH.

The lumber industry and the lumber trade both showed very satisfactory returns for the year 1911, stated Hon. Price Ellison in the British Columbia Legislature when introducing his budget. "I ventured to predict in my last budget speech that 1911 would prove a prosperous year in the lumber trade. My forecast was correct. The steadiness of the lumber market enabled the mills to operate during the entire year though some of those in the interior curtailed their output during November and December, on account of the American mills dumping their surplus out on the markets of the northwest at less than cost price.

"According to the returns made to the chief timber inspector the lumber cut for 1911 was as follows:

"Logs officially scaled west of Coast range 619,000,000 feet; cut from Esquimalt & Nanaimo Railway lands, 144,000,000 feet; logs officially scaled east of Coast range 297,000,000 feet; total, 1,060,000,000 feet.

"Of this amount the total manufactured into lumber was 113,000,000 feet, and the total exported 47,000,000 feet.

"The royalty collections for 1911 exceeded those of 1910 by no less than $50,734.

"The causes of this better return may be summed up as follows:

"1. The crops in the prairie provinces compared favorably with those of 1910.

"2. The record number of incoming settlers increased the demand for dwelling and other houses.

"3. The checks on the dumping from the United States effected by the enforcement of the customs regulations by the new government at Ottawa will prevent the importation of other than real rough lumber.

"4. The lesson taught by the prolonged shutting down of mills in the United States has produced a lasting effect.

"I look forward, therefore, to a still greater stimulus in the lumber trade in 1912—especially as there will be a larger amount demanded provincially owing to our development.

"The supply of pulpwood in the eastern United States has been hopelessly insufficient for the present needs of their people, and they already import one-quarter of the whole of the raw material for their paper mills from Canada. We are also exporting to them $4,000,000 worth of manufactured pulp for the paper mills of the eastern states.

"I look forward to a rapid growth in that industry. I may add that the completion of the Panama canal in 18 months time cannot but have enormous influence in the development of our lumber trade. It can hardly fail in fact to become by far the most profitable of our staple industries. The cheaper freight rates, which will necessarily accompany the opening of the canal, must give an unprecedented stimulus, and will at the same time prevent a recurrence of periods of depression. With an easy means of communication secured to us by water as well as by land the depletion of the world's timber in other regions cannot fail to make the timber output of our forest lands a most permanent source of revenue for generations to come.

"This province more than two years ago outstripped Quebec in the production of lumber, while in 1910 her output was on a par with that of Ontario. It does not require the eye of a prophet to see that, with a vast proportion of her virgin forests still untouched she will, in proportion to her size take prominent place within a year or two among the great timber producing countries in the world.

"In order to bring about this end and to encourage the establishment of the paper making industry in the province the government granted in 1901, 21 year leases of pulp forests to companies on liberal terms. In 1903 the law granting pulp leases was repealed. The annual rental now paid under these leases, is two cents per acre and a royalty of 25 cents per cord of pulp wood cut. Four companies are now either erecting or operating plants, the British Canadian Wood Pulp Paper Company, the Swanson Bay Forests Wood Pulp & Lumber Mills, the Ocean Falls Company, Bella Coola and the Powell River Paper Company. As proof of the prosperity of the industry the last named company is filled up with orders for all the paper and pulp it can produce.

"I believe that the mills of Powell River, Swanson Bay, Howe Sound and those of the British Columbia Wood Pulp and Paper Company, vast as they are, are but the pioneers of an enterprise which will fling its tentacles all over the world.

"Looking forward into the centuries, one can imagine a time when the great forests of this province will be denuded of most of their timber; but even then, if all the wealth were gone, British Columbia would remain the greatest producing region in the world. No country shares with us our climate or our soil. It is the most congenial for the cottonwood, spruce, balsam, hemlock, and Lombard poplar, which produce the best paper. Already our ships are conveying the output of our forests in pulp and paper to Australia, New Zealand and the Orient, and no far sighted man can doubt that in the near future half of the whole world will be the market place of the pulp and paper produce of British Columbia.

"We have in this province a combination of the three factors which together insure the prosperity of the pulp and paper trade—factors without which the industry can nowhere be successfully maintained. These three factors are (1) cheap water power; (2) cheap timber; (3) cheap transportation in close juxtaposition. Washington, Oregon and California have the last two but they lack that most essential factor—cheap water power. My conviction is, therefore, that we can always compete successfully against other producing countries in capturing the pulp trade."

IRON ORE IN QUEBEC.

The iron ore industry of the Province of Quebec has, in the last few years, shown a serious decline. The bog iron ore deposits of the St. Maurice district and of Drummond county seem to be passing away, and, so far, no other iron ore deposits have been brought into prominence to replace them. In 1911, only 931 tons of local ore were charged into the Drummondville furnace, of the Canada Iron Corporation, the main supply of ore having had to be imported from Ontario. The Radnor furnace of the same company went out of blast in the summer of 1910 and was not blown in during 1911.

INDUSTRIAL ACCIDENTS.

According to the record of industrial accidents kept by the Department of Labor, 61 persons were killed and 178 injured during February, 1912. This record compares very favorably with that of January, when 86 workmen were killed and 214 injured. Compared with February, 1911, the record is still more favorable, as 93 were killed and 197 injured in that month. The worst disaster of the past month was the premature explosion of dynamite on construction work near Fort Frances, Ont., on the line of the Canadian Northern Railway, by which 13 construction hands were killed and six others seriously injured.

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IMPROVEMENT IN HOME CONDITIONS.

It is a familiar phrase among Canadians that the western portion of the country is "land mad," and the statement is strengthened to some extent by the many sheets in the newspapers given up to the description and offerings of western real estate.

It is particularly noticeable that these land booms follow, almost invariably, the extension of the railways, and that the erection of railway yards or other property is always an incentive to the realty men to increase their prices for late comers and industrial concerns.

In the City of Calgary, Alta., the scene of considerable real estate activity, the Canadian Pacific Railway have recently erected a large railway yard, and in order to protect their employees from the high prices of the agents have decided to open a tract of land adjoining the shops for the purpose of giving their employees a chance to erect and build homes and dwellings for their own use.

The lots will be sold at very reasonable prices, and when the employees have been given enough land for this purpose the balance will be offered to the public.

It is not a common thing for the management of our large industrial enterprises, in this country, to take an interest in the home life of their working men. In Great Britain it is much more prevalent, and the results in almost every instance have been satisfactory in the highest degree. The village of Port Sunlight, in England, is almost entirely under the control of the Lever Brothers and their employees, and the result is that laboring classes, speaking generally, have better home conditions than the average mechanic in this country. In the first place the worry of rent payment is entirely eliminated, and the fear of higher prices being asked from time to time is done away with, and the sanitary conditions are kept up to a certain standard.

It is just possible that should more capital industries follow the course of the railway in this matter, the high cost of living would decline.

MUNICIPAL EXPENSES.

Ratepayers and supporters of municipal finances are only too well acquainted with the reckless and thoughtless expenditure of civic moneys by municipal controllers and council men. We have recently had an example of a direct waste of several thousand dollars in waterworks material in one of our larger cities, and the following increase in the tax rate that must result from this expenditure that will never return dividends monetary or otherwise. Recently in and during the council meeting in a Canadian city, a controller questioned a small item for ornaments for the mantel shelf of the Mayor's office. The articles in question may be procured for a few cents, and as they were for decorative purposes only the council man requested that the item be referred back for an explanation.

In due course the item returned with the amount lessened by the sum that had been questioned when the bill was presented for payment. Accompanying the bill a written explanation was offered, and from the composition a reader would be at once impressed with the friction that must exist between certain departments in the civic organization.

As stated above, the item was small but the principle of the thing was apparent from the start. The council man was already aware of the large deficit carried for-

ward from last season and here saw an opportunity to reduce the civic expense. He did not object to the articles of decoration, but expressed his opinion that a lower price could have been paid for the same value and appearance. If the article had been some municipal requirement where utility was the all important point, sarcasm given in answer to a suggestion for expense reduction could not be overlooked; but surely the council member deserves the approval of the citizens in his attempt, however small, to reduce needless civic expenditure.

A GOOD CHANGE IN TENDER WORDING.

In a recent advertisement for the supply of road machinery for one of the smaller municipalities of this country a clause was inserted in the composition to the effect that "Any firm or dealers who personally or through their agents canvass members of the County Council or officials of the council will be disqualified from having their tenders accepted."

This is an unusual clause to notice in a municipal tender but surely it is a criterion of the fair minded intentions of the council members to see that the ratepayers are supplied with the worth of the staple dollar for dollar as well as giving the smaller manufacturer an equal chance in the competition.

PUBLIC HEALTH.

The recent announcement from the Federal Government regarding the new methods to assist the public in the matter of health is the outcome of several suggestions and ideas on the part of municipalities and communities who have tried to combat disease and found themselves handicapped owing to the limited extent of their powers.

The Federal Government are the proper body to direct this campaign for many reasons, chief of which is the unlimited powers enjoyed by that party owing to no restriction being made by boundary lines or municipal borders.

But the federal powers may be greatly strengthened by co-operation of the municipal authorities, and in return the municipal health officers may feel increased powers with the knowledge that suggestions, if practical, will be adopted and enforced with powers that they as individuals do not enjoy.

It is to be hoped that the new office will prove of equal value to the Canadian public with the benefits of the Government inspection of live stock.

Honorable Frank Cochrane has given notice of a resolution providing for a subsidy not exceeding $6,400 a mile for the Temiskaming and Northern Ontario lines, described as follows: From North Bay to Cochrane, not exceeding 252.8 miles. From Englehart to Charlton, not exceeding 7.8 miles From Cobalt to Kerr Lake, not exceeding 3.9 miles. From Iroquois Falls to Timmins, not exceeding 33.6 miles. From Nipissing Junction to North Bay, not exceeding 2.18 miles. Provision is made for the payment of the subsidy upon the certificate of the chief engineer of the Department of Railways and Canals as to the mileage constructed in such manner and in such amounts, and subject to such conditions, if any, as the Governor-in-Council may deem expedient.

THE FIRST COLD WEATHER REINFORCED CONCRETE JOB.

It is interesting to note that the first reinforced concrete factory ever built, the Pacific Coast Borax Refinery at Bayonne, N.J., was constructed partly during the winter of 1897-1898. Reinforced concrete buildings are now so general that it is hard to appreciate the boldness of the conception to construct a building to carry actual working loads of 400 lbs. per sq. ft. out of a material which had been previously used almost exclusively in foundations and at a time when the placing of concrete in the winter was considered absolutely erroneous. The contractors for this building were the Ransome & Smith Company, while Ernest L. Ransome was the designer. That the work was well done and the design well made is evidenced by the way the building stood the severe fire which visited it in the spring of 1902.

The construction was begun late in the fall of 1897 when the ground was frozen. In placing the foundations salamanders with long legs were placed in the excavations to keep the concrete from freezing. Most of the broken stone was brought down in scows from the Palisades of the Hudson River and was piled near the cement shed. The size of the stone was limited to particles passing a 2-inch ring, while for much of the work a 1-inch size was employed. There was so much fine material left in the rock that only a small quantity of sand averaging not more than 10 per cent. was needed. This stone pile was heated by steam pipes from a central plant to a temperature of about 80 deg.

The cement and stone were measured in barrows, dumped into a hopper which discharged into a car. This car was hauled by a cable through a subway and then up an incline to about 30 ft. above the hopper and about 400 ft. distant, where it was automatically tipped into a chute leading to the mixer. Salt was added to the water used in the proportion of 8 lbs. of salt to each barrel of water. The mixer was one of the early Ransome mixers, and it discharged into a trough containing a screw conveyor which delivered the concrete to a vertical bucket elevator and this hoisted the material to the storey where it was required and dumped upon a platform which held about one cu. yd. A steam engine operated the car, mixer and elevator, besides operating a number of machine tools.

One of the most interesting points of this building is the double walls. The total thickness of all of the walls is 16 ins. for the entire height of the building, the hollow space varying from 10 ins. to 12¼ ins. These walls were constructed in three feet sections and the concrete was kept from freezing by placing salamanders in the hollow walls. The work was enclosed by canvas, floor by floor, and salamanders were also used here. This method of concreting in cold weather proved very satisfactory, and the cost of this building per cu. ft. of contents was less than 5 cents, which is a remarkable showing when everything is considered.

PANAMA CANAL REPORT.

The recent report of the volcano under the Panama canal has proved, upon investigation, to be false; the steam and other manifestations of heat are said to arise solely from the oxidation of pyrites and that the trouble is disposed of after the portion is uncovered for a few days.

THE PRINCIPLES OF SPECIFICATION AND AGREEMENT WRITING.

By C. R. YOUNG, A.M. Can. Soc. C.E.

(Registered in Accordance with the Copyright Act.)

Final Article.

THE AGREEMENT.

In the agreement is recorded the formal promise of the Contractor to perform certain labor and supply certain materials in return for a specified consideration promised by the Owner. The general business and legal relationships involved in the whole arrangement between these two parties thus properly require statement here, rather than in the "General Clauses" of the specifications.

While it is impracticable to here attempt an outline of all the stipulations which might find place in engineering agreements, the following matters are of essential importance to such instruments and have mention, in one form or another, in most of them. The items set down do not necessarily represent the titles of corresponding clauses, but merely ideas which should be embodied in some form or other in the agreement:—

(1) A title clause.
(2) Description of subject-matter.
(3) Inclusion of specified documents.
(4) Satisfaction of the Engineer.
(5) Contractor's Risk and Obligations.
(6) Commencement and Completion.
(7) Liquidated damages.
(8) Disputes and Arbitration.
(9) Dismissal of Contractor.
(10) Liens.
(11) Assignment of Contract.
(12) Consideration.
(13) Binding of Successors and Assigns.
(14) Dating.
(15) Signatures.
(16) Witnessing.

(1) **A Title Clause.**—This clause, which is naturally the first one of the agreement, records the making of an agreement on a certain day between parties who are named, numbered and described. The following is a simple illustration:—

> "ARTICLES OF AGREEMENT, made this twentieth day of March in the year One Thousand Nine Hundred and Twelve between the Jones Construction Company, hereinafter called the "Contractor," of the First Part, and the Municipal Corporation of the Town of Blankville, hereinafter called the "Corporation," of the Second Part."

The order in which the parties are named is immaterial, but usually the Contractor's name is placed first.

(2) **Description of Subject-Matter.**—Only a very concise description of the work which the Contractor binds himself to do in return for the consideration mentioned should be placed in the agreement. A description by title and location merely, affording some aid to the identification of the plans and specifications, is sufficient. For the general and detailed descriptions of the work, reference is made in this clause to the plans and specifications which are declared to be a part of the agreement. An example of a clause embodying the above-mentioned features, and which would form the second clause of the agreement, is the following:—

> "WITNESSETH, that in consideration of the payments and covenants hereinafter mentioned to be made and performed by the Corporation, the Contractor hereby agrees to furnish all materials, tools and appliances and perform all labor necessary for the construction of a Reinforced Concrete Arch Bridge over the White River on Robert Street in the Town of Blankville, and in the Province of Ontario, in accordance with the plans and specifications prepared by John James Smith, Civil Engineer, which are hereby incorporated with and declared to be a part of this contract."

(3) **Inclusion of Specified Documents.**—It is necessary, in order that plans and specifications may be included as a part of the contract, that such incorporation be declared, either in the clause setting forth the subject-matter, as above, or in a separate clause. The inclusion of detail or explanatory plans may be covered by this separate clause or, as has already been pointed out, by the specific clause of the specifications referring to plans.

(4) **Satisfaction of the Engineer.**—Although it may have been provided in the specifications that the work is to be done under the general supervision of the engineer and to his satisfaction, it is desirable to include this statement in the agreement as well. The status of the engineer and the important relation which he is to bear to the contracting parties is thus acknowledged and declared in the agreement—the very soul of the contract.

(5) **Contractor's Risk and Obligations.**—The conditions under which the Contractor accepts the contract, in so far as legal responsibilities of a general character are concerned, should be stated here. It must be made plain that the Contractor cannot secure immunity from the pledges of the contract on the ground of unforeseen obstacles or accidents. One of the reasons for the Owner letting the work by contract at all is to relieve himself of the risks and responsibilities incidental to the project, and when a Contractor agrees to do the work for a certain sum it is assumed that he has taken full account of all eventualities in his tender. He, therefore, cannot secure a release on the grounds of undue difficulties if the work be capable of performance by human agencies. Responsibility for accidents due to his own operations should be made to include the defence of all suits for damages arising from this source. A customary and satisfactory phrasing adopted in this clause is that "the Contractor shall indemnify and save harmless the Owner with respect to actions and damages, etc." Conformity to existing building and sanitary laws is to be required of the Contractor, and the responsibility for their violation placed upon him.

(6) **Commencement and Completion.**—If the times of commencement and completion and the required rate of progress have been defined in the specifications, as has been recommended in the present discussion, it is sufficient for the agreement to state that in these respects the work shall be done in accordance with the provisions of the specifications.

(7) **Liquidated Damages.**—Failure of the Contractor to complete the work on time, should entitle the Owner to collect such damages as may have been actually sustained by the default. The legality of fixing beforehand, or "liquidating," the damages has been confirmed

many times by the courts, and there are on record numerous cases where damages have actually been collected from a delinquent Contractor.

But while this principle is well established, it is a matter of common observation that the cases where damages have been recovered from the Contractor are very few compared with those which have been decided in his favor. The reasons are to be found both in the defective preparation of contracts and in the failure of the Owner to comply with the conditions upon which the Contractor's promise was based.

Perhaps the most frequent evidence of weakness in contract stipulations respecting non-completion on time is the fixing of liquidated damages far in excess of the actual damages. In such a case only the actual damages can be recovered from the Contractor, since the contract legally provides for the exaction of a penalty. The disguising of a penalty under the term "liquidated damages" cannot affect the character of the clause, for its exact nature is judged from the contract as a whole and not by the particular term employed. If, however, the actual damages cannot be determined, any amount which does not appear grossly disproportionate to the value of the work done may be collected provided all other conditions have been complied with.

The circumstance which most frequently deprives the Owner of the right to collect damages from the Contractor for failure to complete on time is the contributory delay of the Owner himself. This may result from the Owner failing to deliver up the site to the Contractor at the time specified in the contract for commencement or from delays or suspension of work during progress. It is possible that this contingency might be met in a legal manner by providing in the contract that delays caused by the Owner up to a certain maximum number of days should automatically extend the time of completion by an equal number of days, and that liquidated damages should be calculated from this altered time of completion.

Contrary to the popular impression, it is not essential that a clause conferring on the Owner the right to collect liquidated damages must, in order to be legal, be accompanied by a corresponding bonus clause. There are many cases on record where damages have been recovered without a bonus clause in the contract at all. This much may be said, however, that its inclusion imparts to the contract an increased degree of mutuality and removes to some extent the stigma of one-sidedness. In addition, the reasonableness of the amount fixed as liquidated damages is enhanced by the declared willingness of the Owner to pay a similar amount per day for every day by which his possession of the work is hastened.

(8) **Disputes and Arbitration.**—Most disputes arising under the contract are preferably subject to final settlement by the engineer, as has already been pointed out in discussing the General Clauses of the specifications. These decisions will be upheld by the courts unless the existence of prejudice, partiality or fraud is proven. There are nevertheless many questions upon which an appeal from the decision of the engineer to a specified board of arbitration should be allowed. In this category would come disputes relating to payments, alterations, extras, Contractor's delay and similar business or non-technical matters, upon which a mixed board might properly pass. To safeguard findings by arbitration, its conduct should be such as is sanctioned by law. The character of the tribunal should be definitely fixed in the contract, the scope or subject-matter of arbitration fixed, and the procedure of the board should be proper and without partiality. While the common practice is to specify a board of three arbitrators, much may be gained in despatch at least by the reference of disputes to one man of large experience and of undisputed ability and integrity.

However much the contracting parties may have endeavored to prevent litigation by carefully-framed provisions for arbitration, either party may refuse to be bound by the award of the arbitrators and appeal to the courts. The law will not allow any one to barter away his right of being heard in a court of justice. On the other hand, if the arbitration has been properly conducted and the award made in good faith, the courts will generally confirm the decision, so that it rarely pays a dissatisfied party to attempt to upset the findings of the arbitrators.

(9) **Dismissal of Contractor.**—The interests of the Owner demand that he should have the power to terminate the contract for any one of several causes. Sufficient ground for such an act should be afforded by the abandonment of the work by the Contractor or its suspension for over a certain number of days; undue delay in the prosecution of the work; failure to complete the work as a whole or in part by the times mentioned in the contract; violation by the Contractor of any of the covenants or conditions of the contract; or his refusal to comply with the instructions or orders of the engineer. The right of the Owner to take possession of the entire work, including unused materials and the Contractor's plant and camps must be retained, for otherwise great delay and inconvenience might result from the dismissal of the Contractor and the resumption of operations under new auspices. The Owner should also stipulate in the contract that the work may be completed by day labor, by contract or by any means which may seem desirable to him under the circumstances. In case the entire work should under these conditions cost more than the tender of the original Contractor, the means of recovery of the difference should be stipulated.

(10) **Liens.**—The Owner should reserve to himself in the contract the right to discharge all liens or formal claims filed against the Contractor and to deduct the amounts thus paid from any moneys due the latter under the contract.

(11) **Assignment of Contract.**—Assigning or subletting a contract should not be permitted without the consent of the engineer. Otherwise, the Contractor might delegate work to irresponsible and incompetent persons whose incapacity or tardiness might bring great loss to the Owner and chagrin to the engineer.

(12) **Consideration.**—The consideration passing from the Owner to the Contractor may take the form of a lump sum or certain prices per unit of measurement for each of the different classes of work covered by the contract. The prices for extras and the basis of remuneration for Force and Material Account work should also appear in this portion of the agreement.

(13) **Binding of Successors and Assigns.**—Each of the contracting parties, should in his own interests, require the contract to extend to and bind the heirs, executors, administrators and assigns of the other, if an individual, or the successors and assigns of an incorporated company or municipal corporation.

(14) **Dating.**—It is not desirable to date an agreement twice, because of the liability of disagreement and consequent invalidating of the contract. For this reason it is a common practice to record the signatures as being

made the "day and year first above written." Where a contract is drawn in one Province, State or country to be enforced in another, it is desirable to establish the place of its closing, since the question of the laws under which the contract is to be interpreted should not be clouded by uncertainty as to the place of making.

(15) **Signatures.** — Signatures should obviously correspond precisely to the names of the parties in the body of the contract. If an incorporated company, commission or governmental corporation is entering into a contract, the signatures of its proper officers should be required and in case of a governmental corporation the Corporate seal should also be affixed.

(16) **Witnessing.** — The various signatures to the contract should, for purposes of identification, be witnessed. It is preferable to have the execution of the instrument acknowledged before a notary public or other public officer authorized to act in such a capacity. The courts will in this case accept the instrument as identified and admit it at once as evidence.

PRACTICAL SUGGESTIONS.

Language, Spelling, Punctuation, etc. — Since the guiding principle in the interpretation of contracts is the intention expressed by the parties, it is evident that the best kind of language to use in the preparation of such instruments is that which most clearly expresses this intention. There is no special virtue in legal phraseology and the engineer has no need to employ it except, perhaps, in special cases where definiteness of statement may be furthered by its use. The safest practice for one without special legal training is to employ only simple, plain langauage involving words and terms the meaning of which is well understood in the locality where the work is to be done. Clearness requires the employment of short rather than long sentences and it is frequently desirable, rhetorical principles notwithstanding, to repeat words and phrases where other expressions would not convey precisely the same meaning. Brevity, although commendable, should not be secured by the omission of words as understood, since the avoidance of ambiguity should be one of the first cares of the contract-writer. In this connection it is well to remember that the intention of the contract is judged by the meaning of the words and not by what the engineer may allege he intended to express. While specifications and agreements are not a proper field for the rhetorician, the inelegances of the imperative mood and of such barbarisms as "the same" should be avoided. Mistakes in grammar, spelling or punctuation will not be allowed to invalidate the contract, but their occurrence may precipitate disputes and ultimately lead to litigation. Anything which distorts a sentence or obscures the meaning of the instrument in any particular should therefore be avoided. Even if accuracy in this respect does not serve to keep the case out of the courts, the task of interpreting the contract will be much facilitated thereby.

Balanced Treament.—Each of the various matters covered in a contract should be given that consideration which its importance demands. It frequently happens that an engineer through lack of familiarity with certain phases of the work covered in his specifications dismisses them with the statement that they shall be "to the satisfaction of the engineer," while pages of space are given over to the description of relatively unimportant matters with which he was well acquainted. The incorporation of characteristically brief manufacturers' specifications for certain materials and apparatus in the specifications of the engineer is likely to result in this curious lack of due proportion. From the placing of undue emphasis on certain matters the Contractor may be led to slight things of equal, or perhaps greater, importance in his endeavor to live up to the letter of the contract.

Arrangement.—The clauses of a contract should not be thrown together in a haphazard manner but should be arranged in some logical order. It is most convenient to divide the specifications up into divisions corresponding to the various contracting interests affected, or sometimes even to issue a separate specification for each. Within these divisions an orderly arrangement should, of course, be followed. This may be in chronological order or in the order of importance, but neither can be followed rigidly. The best order is a combination of these and one in which one clause or subject suggests another. Each item should be contained in an individual numbered clause, a unit in itself and not dependent upon any other clause. It should be remembered also that the ease with which a specification may be used is greatly enhanced by the use of marginal references.

Checking.—All specifications and draft agreements should be carefully checked before being issued from the office of the engineer, and in case of important contracts this should be done by a lawyer as well as by the engineer. Checking of his own work by the writer of the contract should not be done immediately after its preparation but preferably a few days later. In no case should the work of a typist be allowed to go out unchecked.

Changes and Corrections.—Changes in the text of the contract should not be made by erasure but by lining out the words or portions altered. In this way it is established that most, and perhaps all, of the changes were made while the document was being transcribed and before it was finally signed. As a safeguard, it is well also to have each signer of the contract initial such changes. Care should be taken to see that the requisite changes in the plans are made at the same time.

WATERWORKS OF ST. THOMAS, ONT.

This department of the city's utilities showed a net profit of $18,500 during the past year, according to a report recently issued by the water commissioners of that city. The population of this city is placed at 15,240, and the water is conveyed to the citizens by means of 29 miles of street mains; the hydrants number 168, and the reservoir capacity is 25,000,000 gallons.

The source of supply is Kettle Creek and from artesian wells, and this water is filtered before reaching the taps by means of six coagulating filters using alum, ⅔ grain to the gallon, as a coagulant.

Under the present system the water is pumped directly from the suction well through the filters into the mains. The coagulant is applied in the well, so that its opportunity for performing its work before entering the mains is very limited.

Under the new system, now in course of construction, the water will be taken from the present suction well by an electrically driven centrifugal pump. The pump is manufactured and supplied by the Canadian Boving Company, and has a capacity of 2,100 imperial gallons per minute. It pumps against a head of 58 ft.; speed 720 r.p.m. It is driven by a 3 phase Lancashire motor capable of developing 60 b.h.p. when running at 720 r.p.m. A reserve steam driven centrifugal pump will also be installed, which is

also manufactured and supplied by the Canadian Boving Co. This pump has a capacity of 3,500 imperial gallons per minute. It pumps against a head of 58 ft.; speed 550 r.p.m. It is driven by an Alley and MacLellan high speed engine capable of developing 94 h.p. at 550 r.p.m., when steam is at 100 lbs. per square inch.

The above mentioned pump will raise the water through an 18-inch cast iron pipe to the aerator and coagulating basin, located on the high ground to the north-east of the works. At the aerator it will be broken into a spray so that every particle will come into contact with the air. From the aerator, it will pass into the coagulating basin which has a volume of about 400,000 gallons. Here, the water will remain four hours or more, giving the coagulant time to have its full effect, and settle the matter held in suspension, before passing through the 20-inch pipe line and through the filters by gravity. From the filters it goes to the clear water basin, where one million gallons of filtered water will be held in reserve. From there it will be pumped directly into the mains by the pumps which are at present in use.

In addition to the 12-inch vitrified pipe from the dam directly to the suction well, an 18-inch cast iron pipe line has been laid. A man-hole and sluice gate is placed in the pipe line. This will furnish ample supply from the dam when the reservoir is emptied.

The following table shows the amount of water pumped for the year, tabulated monthly, and the amount of fuel and alum used:—

	Coal		Wood	Alum	Gallons of
	Tons.	Lbs.	cords.	lbs.	water pumped.
January	83	500	½	3,100	45,322,560
February	76	1,000	½	3,400	41,342,570
March	80	900	1	5,100	44,207,695
April	76	1,600	1	4,800	40,853,250
May	78	100	1½	4,000	42,549,455
June	76	1,300	1	4,000	44,521,645
July	79	1,200	½	2,800	44,125,560
August	82	700	½	2,800	43,829,415
September ...	76	1,400	1	2,500	41,314,455
October	80	1,700	2½	3,100	40,602,060
November	80	900	2½	2,800	41,462,055
December	91	900	½	3,000	42,634,985
	963	200	13	41,400	512,766,605

COAL IN WESTERN CANADA.

It is estimated by the Geological Department of Canada that the total coal content of the three Provinces of Manitoba, Saskatchewan and Alberta, together with Eastern British Columbia, is 143,490,000,000 tons, covering an approximate area of 22,506 square miles. In the above total it is estimated that the various classes of coal occur in the following proportions:—

	Tons.
Anthracite	400,000,000
Anthracite and semi-anthracite	860,000,000
Bituminous and semi-anthracite ..	43,070,000,000
Coal and Lignite Coal	99,160,000,000
	143,490,000,000

The total coal production of the Province of British Columbia for the year 1910 was 2,800,046 tons; Alberta [illegible],000 tons, and Saskatchewan 224,500 tons.

THE PRACTICAL DESIGN OF REINFORCED CONCRETE FLAT SLABS.

By Sanford E. Thompson.

(Continued from last issue.)

Moment at Centre of Slab.—It is possible to adopt the Eddy theory to the design of the centre of the slab as well as to the supports. In practical design, however, as has been indicated, the thickness of the slab is determined by the thickness at the support, which is always the greater. But, in order to avoid too wide spacing of the bars and to adapt the centre reinforcement to that over the supports, more steel is generally run through the slab than the results of tests would show to be necessary. Consequently, instead of considering this from a theoretical standpoint alone, safe values for the bending moments may be selected, based on general principles of mechanics and qualified by actual tests.

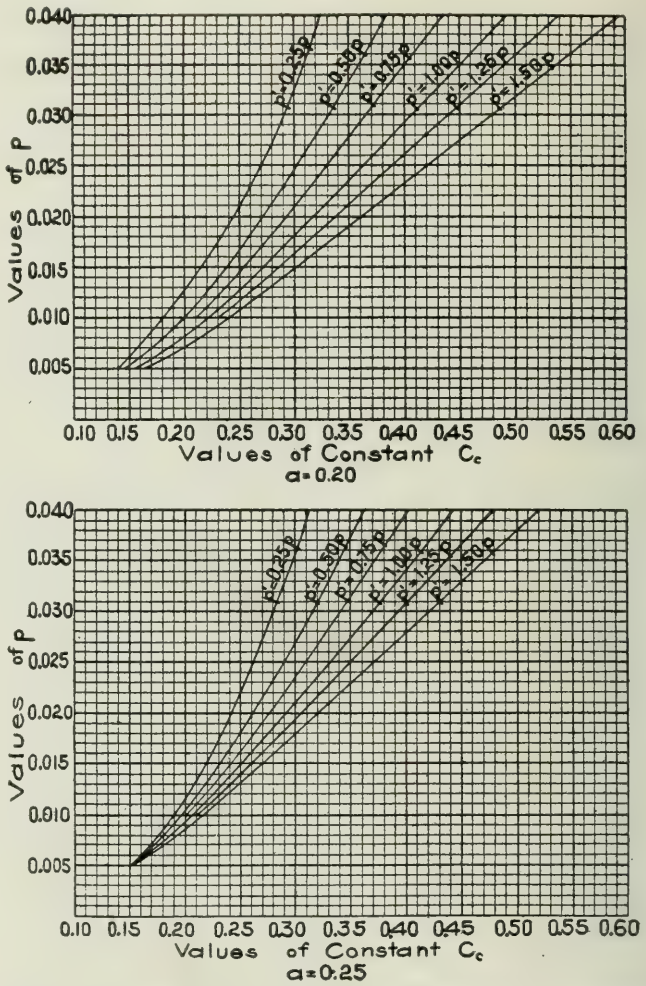

Fig. 6.—Diagram Giving Values of Constants in Formula.

$$fc = \frac{M}{Ccbd^2} \quad \text{for } a = 0.20 \text{ and } a = 0.25$$

$$a = \frac{\text{Depth of Steel in Compression.}}{\text{Depth of Steel in Tension.}}$$

$$p = \frac{\text{Area of Steel in Tension.}}{\text{Area of Concrete above Steel.}}$$

Let l_1 = distance between lines of inflection. This distance will be about 3/5 of the net span between column heads

For the rectangular reinforcement, if the slabs between the points of inflection were simply supported, we should have a moment of $wl_1^2/8$. However, the bending moment in the Minneapolis tests, based on the maximum stresses under uniform working load is about $wl_1^2/33$. It would appear amply safe, therefore, to adopt a value of $M = wl_1^2/12$.

For the diagonal reinforcement, the steel runs in two directions, and considering both theory and test, a value of $M = wl_1^2/24$ is conservative to use for the steel in each direction.

Cross Steel Between Columns.—In flat slab floors, cracks are apt to occur between columns on rectangular lines, because, since the span is shorter, the deflection is less than in the centre of the slab. To prevent these cracks, it is advisable to place cross reinforcement of small bars in the top of the slab.

Tables for Design of Slabs.—The accompanying tables give thicknesses of slab, reinforcement, and size of column head, for various column spacings and loads.

Three arrangements for steel over the column head are chosen: The first where the area of steel in the top is twice the area of steel in the bottom; the second where the two are equal; and the third where the area of steel in the bottom is one and a half times that in the top. This gives the designer a variety of thicknesses of slab. The percentages of steel selected are those which produce, with the given conditions, a compressive stress of 800 lb. per sq. in. in the concrete and 16,000 lb. in the steel. In order to allow 800 lb. in the concrete, it should be mixed in proportions as rich as 1 part cement to 2 parts fine aggregate to 4 parts coarse aggregate. Poisson's ratio is assumed as 0.1, which from recent tests appears to be a fair value.

$$fc = \frac{}{Ccbd^2} \text{ for } \alpha = 0.30$$

$$\alpha = \frac{\text{Depth of Steel in Compression.}}{\text{Depth of Steel in Tension.}}$$

$$p = \frac{\text{Area of Steel in Tension.}}{\text{Area of Concrete above Steel.}}$$

Table 1.—Design of Flat Slabs.

Thickness of Slab, Areas of Steel and Sizes of Column Head are Given for Different Spans and Percentages of Steel. Live Load 100 lb. per sq. ft.

Span between centres of columns in feet.	Ratio of cross-section of steel in tension to concrete below steel. (p)	Ratio of cross-section of steel in compression to concrete below steel in tension. (p′)	Distance from bottom of slab to centre of gravity of steel in tension. (d)	Approximate total depth of slab. (t)	Diameter of column head.	*Area of steel over column in tension.	*Area of steel over column in compression.	Minimum area of steel between columns per foot of width of diagonal band.	Minimum area of steel between columns per foot of width of rectangular band.
ft.			in.	in.	ft.	sq. in	sq. in.	sq. in.	sq. in.
12	0.014	0.007	4¼	5½	2.00	4.50	2.25	0.16	0.09
12	0.017	0.017	3¾	5	2.00	4.81	4.81	0.17	0.09
12	0.022	0.033	3½	4¾	2.50	7.26	10.90	0.18	0.09
14	0.014	0.007	5	6¼	2.25	5.94	2.97	0.19	0.11
14	0.017	0.017	4½	5¾	2.75	7.93	7.93	0.20	0.11
14	0.022	0.033	4	5¼	3.00	9.96	14.95	0.21	0.11
16	0.014	0.007	6	3½	3.00	9.51	4.76	0.22	0.12
16	0.017	0.017	5¼	6½	3.25	10.95	10.95	0.23	0.12
16	0.022	0.033	4½	5¾	3.75	14.01	21.05	0.24	0.12
18	0.014	0.007	6¾	8¼	3.50	12.48	6.24	0.26	0.14
18	0.017	0.017	6	7½	3.75	14.42	14.42	0.27	0.14
18	0.022	0.033	5	6¼	4.50	18.67	28.00	0.28	0.14
20	0.014	0.007	7¾	9¼	4.00	16.36	8.18	0.30	0.16
20	0.017	0.017	6¾	8¼	4.50	19.47	19.47	0.31	0.16
20	0.022	0.033	5¾	7¼	5.00	23.89	35.80	0.32	0.15
22	0.014	0.007	8½	10¼	4.50	20.21	10.11	0.34	0.18
22	0.017	0.017	7½	9	5.00	24.05	24.05	0.34	0.17
22	0.022	0.033	6½	8	5.75	31.05	46.60	0.35	0.16
24	0.014	0.007	9½	11¼	5.00	25.10	12.55	0.38	0.20
24	0.017	0.017	8¼	10	5.75	30.41	30.41	0.39	0.20
24	0.022	0.033	7	8½	6.50	37.80	56.70	0.40	0.19

* Area of steel over column head = circumference of column head in inches × d × p or p′ depending upon whether the steel is in tension or compression. This steel is assumed as distributed over the entire widths of the bands. Thus if a band of steel has 2 sq. in. steel in section, the area, effective, for two bands will be 8 sq. in. (See example.)

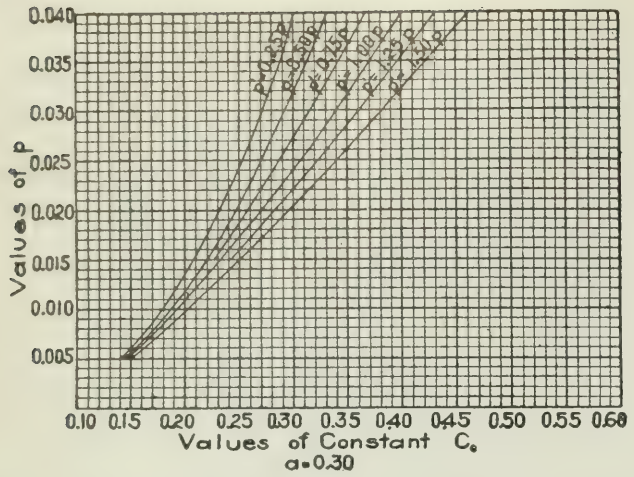

Fig. 7.—Diagram Giving Values of Constants in Formula

The size of column head has been figured for a shear of 60 lb. per sq. in. on a circle a distance, t, (the thickness of slab) outside of the column head. This shear is used simply as measure of the diagonal tension. The value is somewhat larger than is permitted in beam design but appears to be warranted in the case of flat slabs.

The steel in the centre of the slabs has been figured for a stress of 16,000 lb.

Diagrams for Designing Slabs.—To provide for cases not covered by the table, curves for values of C_s and Ce are given so that the moment under various conditions can be readily figured from the formula for the bending moment given in a preceding paragraph.

Diagrams for Determining Steel in Top and Bottom of Beams or Slabs.—In Figs. 5 to 8, curves are plotted for finding the values of the constants Cc and Cs in the formulas for the steel and concrete stresses in beams or slabs with steel in top and bottom. The curves are drawn for different values of a, the ratio of distance of steel in com-

Table 2.—Design of Flat Slabs.

Thickness of Slab, Areas of Steel and Sizes of Column Head are Given for Different Spans and Percentages of Steel. Live Load 150 lb. per sq. ft.

Span between centres of columns in feet.	Ratio of cross-section of steel in tension to concrete below steel. (p)	Ratio of cross-section of steel in compression to concrete below steel in tension. (p′)	Distance from bottom of slab to centre of gravity of steel in tension. (d)	Approximate total depth of slab. (t)	Diameter of column head.	*Area of steel over column in tension.	*Area of steel over column in compression.	Minimum area of steel between columns per foot of width of diagonal band.	Minimum area of steel between columns per foot of width of rectangular band
ft.			in.	in.	ft.	sq. in	sq. in.	sq. in.	sq. in.
12	0.014	0.007	4¾	6	2.25	5.64	2.82	0.18	0.10
12	0.017	0.017	4¼	5½	2.50	6.81	6.81	0.19	0.10
12	0.022	0.033	3½	4¾	3.00	8.72	13.09	0.21	0.10
14	0.014	0.007	5½	7	3.00	8.72	4.36	0.22	0.12
14	0.017	0.017	5	6¼	3.50	11.22	11.22	0.23	0.11
14	0.022	0.033	4¼	5½	3.75	13.22	19.82	0.24	0.11
16	0.014	0.007	6½	8	3.50	12.03	6.02	0.26	0.14
16	0.017	0.017	5¾	7¼	3.75	13.83	13.83	0.27	0.13
16	0.022	0.033	4¾	6	4.50	17.75	26.60	0.28	0.13
18	0.014	0.007	7¼	8¾	4.00	15.32	7.66	0.31	0.16
18	0.017	0.017	6¼	7¾	4.50	18.05	18.05	0.32	0.15
18	0.022	0.033	5¼	6¾	5.50	24.00	36.00	0.33	0.14
20	0.014	0.007	8¼	10	5.00	21.80	10.90	0.34	0.17
20	0.017	0.017	7	8½	5.50	24.70	24.70	0.35	0.17
20	0.022	0.033	6	7½	6.25	31.14	46.70	0.36	0.16
22	0.014	0.007	9	10¾	5.50	26.15	13.08	0.38	0.18
22	0.017	0.017	7¾	9¼	6.25	31.07	31.07	0.39	0.17
22	0.022	0.033	6¾	8¼	7.00	39.24	58.80	0.40	0.17
24	0.014	0.007	9¾	11¾	7.00	36.05	18.03	0.42	0.21
24	**0.016**	**0.013**	**8¾**	**10½**	**7.00**	**36.95**	**29.57**	**0.43**	**0.20**

The values printed in black type are figured for a column head 7 ft. in diameter and the thickness of the slab is increased to withstand the shear. (See example.)

* Area of steel over column head = circumference of column head in inches × d × p or p′ depending upon whether the steel is in tension or compression. This steel is assumed as distributed over the entire widths of the bands. Thus if a band of steel has 2 sq. in. steel in section, the area, effective, for two bands will be 8 sq. in.

If the reinforcing rods are so bent that more than 60 pounds in shear can be allowed on the concrete the thickness of the slab may be decreased, provided the steel areas are increased sufficiently to give the desired strength.

pression from compression sufrace to distance of steel in tension from compression surface, and for different values of p'/p, where p = ratio of cross-section of steel in tension to concrete above it,* and p' = ratio of cross-section of steel in compression to this same area of concrete.

Example.—For a warehouse floor with a live load of 150 lb. per. sq.ft. and a column spacing of 20 ft. each way, what is the necessary thickness of slab, size of column head, and amount of steel?

Solution.—From Table 2 the thickness of slab is given as 8½ in., the size of column head 5.5 ft., and the area of steel as 24.7 sq. in. at top of slab and same amount at bottom of slab over column, using ratio of area of steel in tension to area of concrete below steel as 0.017. Dividing

$$fs = \frac{M}{Csbd^2}$$

$$a = \frac{\text{Depth of Steel in Compression.}}{\text{Depth of Steel in Tension.}}$$

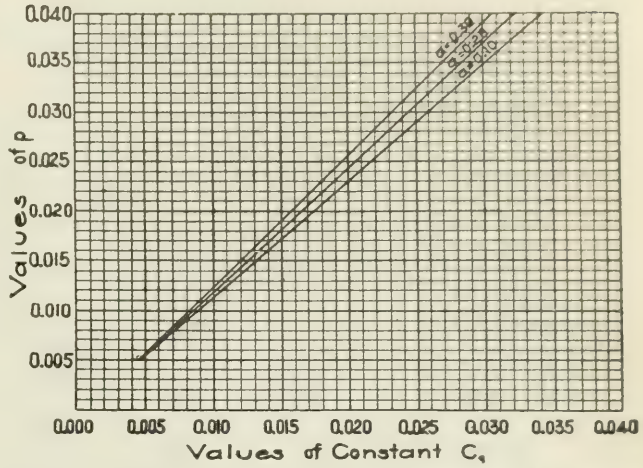

Fig. 8.—Diagram Giving Values of Constants in Formula

* Where the tension steel is at the top, as over the support of a flat slab or beam, the concrete area is taken below the tension steel.

Table 3.—Design of Flat Slabs.

Thickness of Slab, Areas of Steel and Sizes of Column Head are Given for Different Spans and Percentages of Steel. Live Load 200 lb. per sq. ft.

Span between centres of columns in feet. ft.	Ratio of cross-section to concrete below of steel in tension steel. (p)	Ratio of cross-section of steel in compression to concrete below steel in tension. (p′)	Distance from bottom of slab to centre of gravity of steel in tension. (d) in.	Approximate total depth of slab. (t) in.	Diameter of column head. ft.	*Area of steel over column in tension. sq. in	*Area of steel over column in compression. sq. in.	Minimum area of steel between columns per foot of width of diagonal band. sq. in.	Minimum area of steel between columns per foot of width of rectangular band. sq. in.
12	0.014	0.007	5	6¼	2.50	6.60	3.30	0.20	0.10
12	0.017	0.017	4½	5¾	3.25	9.38	9.38	0.21	0.10
12	0.022	0.033	3¾	5	3.75	11.70	17.55	0.23	0.10
14	0.014	0.007	6	7½	3.25	10.31	5.16	0.24	0.13
14	0.017	0.017	5	6¼	3.75	12.02	12.02	0.25	0.12
14	0.022	0.033	4¼	5½	4.50	15.88	23.80	0.26	0.11
16	0.014	0.007	6¾	8¼	4.00	14.26	7.13	0.28	0.14
16	0.017	0.017	5¾	7¼	4.50	16.60	16.60	0.30	0.14
16	0.022	0.033	4¾	6	5.50	21.70	32.55	0.32	0.14
18	0.014	0.007	7½	9	4.75	18.80	9.40	0.33	0.17
18	0.017	0.017	6½	8	5.50	22.92	22.92	0.34	0.16
18	0.022	0.033	5½	7	6.50	29.70	44.60	0.35	0.15
20	0.014	0.007	8½	10¼	5.50	24.71	12.36	0.37	0.18
20	0.017	0.017	7¼	8¾	6.25	29.08	29.08	0.38	0.17
20	**0.019**	**0.029**	**6¼**	**7¾**	**7.00**	**31.35**	**47.85**	**0.39**	**0.16**
22	0.014	0.007	9½	11¼	6.25	31.38	15.69	0.42	0.20
22	**0.016**	**0.012**	**8¼**	**10**	**7.00**	**34.90**	**26.15**	**0.42**	**0.19**
24	**0.014**	**0.006**	**10¼**	**12**	**7.00**	**37.90**	**16.24**	**0.46**	**0.22**

The values printed in black type are figured for a column head 7 ft. in diameter and the thickness of the slab is increased to withstand the shear. (See example.)

* Area of steel over column head = circumference of column head in inches × d × p or p′ depending upon whether the steel is in tension or compression. This steel is assumed as distributed over the entire widths of the bands. Thus if a band of steel has 2 sq. in. steel in section, the area, effective, for two bands will be 8 sq. in.

If the reinforcing rods are so bent that more than 60 pounds in shear can be allowed on the concrete the thickness of the slab may be decreased, provided the steel areas are increased sufficiently to give the desired strength.

$$p = \frac{\text{Area of Steel in Tension.}}{\text{Area of Concrete above Steel.}}$$

these values by 4, as each end of the bands is effective, we have 24.7/4 = 6.2 sq. in. as the area of steel in each band. For this may be used twenty ⅝-in. round bars spaced 5 in. centre to centre for both tension and compression steel.

The amount of steel required at centre of rectangular band is 0.17 sq. in. per ft. of width. Placing a ⅝-in. round bar every 10 in. gives more than the necessary area, but ease in placing the steel makes up for the extra amount. The amount of steel required at centre of diagonal band is 0.35 sq. in. per ft. of width. ⅝-in. round bars every 10 in. will thus give necessary amount of steel.

Table 4.—Design of Flat Slabs.

Thickness of Slab, Areas of Steel and Sizes of Column Head are Given for Different Spans and Percentages of Steel. Live Load 300 lb. per sq. ft.

Span between centres of columns in feet.	Ratio of cross-section of steel in tension to concrete below steel. (p)	Ratio of cross-section of steel in compression to concrete below steel in tension. (p′)	Distance from bottom of slab to centre of gravity of steel in tension. (d)	Approximate total depth of slab. (t)	Diameter of column head.	*Area of steel over column in tension.	*Area of steel over column in compression.	Minimum area of steel between columns per foot of width of diagonal band.	Minimum area of steel between columns per foot of width of rectangular band.
ft.			in.	in.	ft.	sq. in	sq. in.	sq. in.	sq. in.
12	0.014	0.007	5¼	6½	3.50	9.72	4.86	0.24	0.12
12	0.017	0.017	4½	5¾	4.25	12.27	12.27	0.25	0.11
12	0.022	0.033	3¾	5	5.00	15.56	23.30	0.26	0.10
14	0.014	0.007	6¼	7¾	4.25	14.03	7.02	0.29	0.13
14	0.017	0.017	5¼	6½	5.00	16.84	16.84	0.30	0.12
14	0.022	0.033	4¼	5½	6.00	21.18	31.72	0.31	0.11
16	0.014	0.007	7	8½	5.00	18.48	9.24	0.33	0.15
16	0.017	0.017	6	7½	6.00	23.10	23.10	0.35	0.15
16	0.022	0.033	5	6¼	7.00	29.05	43.50	0.35	0.12
18	0.014	0.007	7¾	9¼	6.00	24.59	12.30	0.39	0.17
18	0.017	0.017	6½	8	7.00	29.18	29.18	0.40	0.16
18	**0.015**	**0.015**	**6¾**	**8¼**	**7.00**	**26.74**	**26.74**	**0.39**	**0.15**
20	0.014	0.007	8¾	10½	7.00	32.32	16.16	0.43	0.19
20	**0.015**	**0.011**	**8½**	**10¼**	**7.00**	**33.65**	**25.36**	**0.43**	**0.18**
22	**0.012**	**0.003**	**10¾**	**12½**	**7.00**	**34.00**	**8.50**	**0.47**	**0.22**
24	**0.010**	**0.000**	**13½**	**15½**	**7.00**	**35.64**	**0.00**	**0.51**	**0.25**

The values printed in black type are figured for a column head 7 ft. in diameter and the thickness of the slab is increased to withstand the shear. (See example.)

* Area of steel over column head = circumference of column head in inches × d × p or p′ depending upon whether the steel is in tension or compression. This steel is assumed as distributed over the entire widths of the bands. Thus if a band of steel has 2 sq. in. steel in section, the area, effective, for two bands will be 8 sq. in.

If the reinforcing rods are so bent that more than 60 pounds in shear can be allowed on the concrete the thickness of the slab may be decreased, provided the steel areas are increased sufficiently to give the desired strength.

PUBLIC EXPENDITURE IN MONTREAL.

The plans of City Engineer Janin, which have been submitted to the Board of Control, and which it would seem are likely to be acceptable to the Board and to the City Council, involve the expenditure of upwards of $1,000,000 on street paving in the city of Montreal, this amount being $50,000 to $75,000 greater than last year. Residential streets will be macadamized at an average cost of $12.00 per square foot, the granite rate ruling about the same price. Altogether there are some fifty streets or sections of streets to be paved with approximately 65,000 square yards of macadam and granite, the latter being used on streets where there is heavy traffic. It is understood that well on to $9,000,000 will be spent by the government on buildings in Montreal and on improvements to the Montreal harbor and rivers St. Lawrence and Ottawa. The supplementary estimates include upwards of half a million dollars for expenditure on government buildings in Montreal and other works in the city or in suburbs of the city. In addition to this $6,000,000 has already been passed by statute to the Montreal Harbor Board and $1,658,000 for the deepening of the St. Lawrence, and there is $310,000 to provide for dredging plant for the river from Montreal to Father Point. Improvements to the Lachine Canal amount to $200,000, and a considerable sum will also be expended on the portion of the Ottawa River, known as Back River, which flows past the north side of the Island of Montreal.

PURIFICATION OF WATER BY FILTRATION.*

By R. Winthrop Pratt, M. Am. Soc. C.E.

The filtration of public water supplies for the purpose of removing sediment and other impurities has been practised in Europe, especially in England, for the last 60 or 70 years, or more.

The method used was what is now called the slow sand system, and consisted in passing the water through sand beds at relatively slow rates; and without first using chemicals to produce a coagulation of the impurities. European methods of filtration were proposed for use in this country as early as 1866, and during the few years following were installed in several of our smaller cities. In some cases, where the character of the water supply was similar to that of the English supplies, the filters were successful; but in other cases, where turbid waters were treated, success was not attained.

In 1890, the Massachusetts State Board of Health, at its Lawrence Experiment station began an extended investigation of the principles underlying the purification of water by filtration, and of the nature of the processes involved. Merrimac river water was used in these studies.

Three years later, in 1893, based on the results of the work at the Experiment station, and also following European precedent, a filter was built to purify the entire water supply of the city of Lawrence. This was the first filter in the United States, installed expressly for the purpose of reducing the typhoid fever death rate. Its success is well known —the typhoid death rate having been reduced some 80 per cent. This did much to stimulate interest in filtration in other American cities; and during the next few years the installation of filters of the slow sand type was begun by Albany, Washington, Philadelphia and Pittsburg.

About 1884, there was invented the American or mechanical system of water filtration. The essential features of this method were, and still are, first, the addition of a coagulant to the water before it is applied to the filtering material; second, the passage of the water through the sand layer at a rapid rate; third, provision for cleaning the sand layer in place, by means of a reverse current of water instead of removing the dirty sand, as with the slow sand system.

Mechanical filters were first used principally by paper manufacturers, who required a clear water. Their use as a means of hygienically purifying the water was not generally begun until within the last ten or twelve years. The efficiency of the principles of mechanical filtration for municipal supplies was perhaps first proven during experimental tests at Louisville and Cincinnati, in 1897 and 1898. These cities are representative of a large class in the middle west, which has to use a clay-bearing water, and one that cannot be purified bacterially, or even clarified by the slow sand system. The development of mechanical filtration to its present state of efficiency has been necessary to meet the demands of such cities.

The cost of installing filter plants may range from $10,000 to $40,000 or even $50,000 per 1,000,000 gallons capacity. This unit cost varies with the size of the plant, the character of the water to be treated, the expense necessary to connect with the existing water system, and other local conditions. For example, the cost of installing the raw water pumps would be much less in places along the Great Lakes than it would be on the Ohio river, where the water level fluctuates 50 or 60 feet.

Studies by the Ohio State Board of Health, of 11 filter plants in Ohio, namely, those at

	Cost per 1,000,000 Gals.
Cincinnati	$49,830
Dennison	26,000
Elyria	10,000
Geneva	13,000
Lorain	12,000
Marietta	10,000
Rocky River	14,000
Upper Sandusky	15,000
Vermillion	8,000
Warren	13,000
Youngstown	13,000

have shown the average cost per 1,000,000 gallons capacity to be about $17,000. Excluding the Cincinnati plant, however, which cost $49,830 per 1,000,000 gallons capacity, the average cost of the remaining ten is only $13,000 per 1,000,000 gallons capacity. The average cost per capita (based on ultimate capacity of plant), excluding Cincinnati, was found to be about $1.50.

Slow sand filters are in general more costly to build, but cheaper to operate than mechanical filters. This statement is made with the assumption, of course, that the slow sand filters are installed only where the water is sufficiently clear to enable them to be operated with reasonable periods of service between cleanings.

Operating costs vary greatly with the quality of the raw water and the character of the treatment. Lake waters drawn from points removed from shore, are cheapest to treat; while muddy river waters are most expensive.

Special treatment to remove color or odor add to the cost; and water softening may increase it two or three times. Under ordinary conditions filtered water may be obtained at a cost of $10 per 1,000,000 gallons, including interest and depreciation charges. This figure will vary from $5 to $20.

With slow sand filters the principal operating cost is the labor and maintenance of equipment used for washing the sand. With mechanical filtration, the cost of chemicals and of labor, which are about equal, constitute the largest items.

In Ohio, it was found that the operating costs, excluding interest charges, ranged from $2.55 per 1,000,000 gallons at Elyria to $12.10 at Warren, with Youngstown second highest at $10.67. This great difference in cost is largely due to the superior quality of Lake Erie water taken from a point fairly remote from pollution, over that of the turbid and polluted Mahoning river.

In considering the cost of maintaining a filter plant, attention should be directed to the comparatively small increase in the cost of supplying filtered water over that of supplying unfiltered water. This increase is rarely more than 25 or 30 per cent., and frequently only 10 or 15 per cent. In any case, the increase should not amount to more than 50 cents to $2 per person per year—a small price to pay for enjoying pure water and all of its benefits.

*Paper read before Cleveland Engineering Society.

DISINFECTION OF WATER BY CHEMICALS.*

By Dr. R. C. Perkins.

This term is to be translated more or less literally, as it means merely getting rid of all forms of animal or plant life, which may set up disease or give rise to unpleasant conditions of the water.

Removal of the non-pathogenic varieties was the first of the uses to which chemical disinfection was put, and while at first great things were claimed for the various processes, certain difficulties were found to be present which have modified our actions to a large extent. Of the various chemicals used, the only one which has at present a practical use is copper sulphate, which is used for clearing reservoirs from the fresh water algae which develop in them, especially in the warm weather. In most cases, a strength of about one part of copper sulphate to the million parts of water is sufficient to destroy all the algae, and to leave the water clear after the dead forms have disappeared. It must be considered, however, that it has been found in many cases that the algae return in increased numbers after a short interval, and in others that there are resistant forms which cannot be killed by a dilution which will not be injurious to higher forms of life. The earlier claims that this method would kill pathogenic bacteria in the above dilutions have not been substantiated.

We are at present more interested in the disinfection of water from the standpoint of removal of the pathogenic forms, especially those of the type of typhoid, Asiatic cholera, dysentery, etc. The essential of a successful disinfection would obviously be the total and constant destruction of all of these organisms by the use of quantities of the chemical which would be so small as to cause no danger per se, or interfere with domestic or commercial uses of the water. There are then certain definite indications for the use of a disinfectant, and even for the period of use and the strength of the chemical. There are in general three sets of circumstances leading to disinfection:

1. Impure water with no immediate prospect of permanent improvement. Here the use should be continued until the establishent of a permanent safe supply.

2. Where there is a water supply which has been made safe by filtration or other means, there should be an emergency apparatus at hand for temporary treatment in case of accident to the plant.

3. Where there is a properly constructed filtration plant treating polluted water, it is now considered best to use a small amount of disinfectant **after** the filtration to protect against any possible errors.

With these points as the essential indications for disinfection, one may consider the choice of an agent. Ozone and chlorine are the chief chemical agents to be considered, since the ultra-violet ray is rather physical than chemical. One may say in passing that the latter is entirely unsuitable for our purposes in Cleveland since it will work only in a clear water, necessitating preliminary filtration.

Ozone and chlorine then are left, and they act by the setting free of mo'ecules of so-called nascent oxygen, which has an oxidizing power of extraordinary strength. When water is treated by these agents, the nascent oxygen attacks all organic matter with great vigor, and inasmuch as the effect is in direct proportion to the exposed surface, it is clear that bacteria, being very finely divided organic matter, will be among the first to be oxidized. There is thus no specific action, but the pathogenic germs share the fate of the inert organic matter. The germs, however, are more or less well equipped to meet harmful influence and it thus happens that a very definite amount is necessary, and that some varieties are more resistant than others. Fortunately the varieties which cause the water-borne diseases are among the least resistant.

Both these methods have been extensively tried, and both have their good and bad points. From the enormous increase of the use of chlorine as against the very slow spread of the use of ozone it is clear that the apparent advantages are on the side of the former. Ozone is procured by the passage of an arc through dry air and then passing this air through the water to be treated. The difficulties are: First—the need of an expensive and more or less complex apparatus; Second—the necessity of dry air, requiring a special drying apparatus in addition to the other; Third—the need of a storage reservoir, as there is no other possibility of reserve; Fourth—that the method is not at all standardized.

The main advantage is that the public is so pleased at the idea of the use of life-giving oxygen that it offers no objection to the use of the chemical, though this in greater strengths is a definite poison.

The objections to the use of chlorine, leaving out for the present those without foundation, are: First—the introduction of a chemical with a disagreeable odor, taste and associations; Second—the use of a chemical which is known to have corrosive and bleaching powers.

The advantages of chlorine are the cheapness and simplicity of the process which are not approached by any other method, the standardization, the fact that even where a power mixing plant is used, hand mixing could be readily resorted to, so that there is no danger of an interruption of the dosing.

Neither process affects the turbidity, the hardness or the general appearance of the water.

It is the opinion of most sanitariums that ozone is still in the experimental stage and that chlorine is a disinfectant which has practically revolutionized the water problem. In the United States alone there are over two hundred places which are using the method, and there is a very large and increasing number abroad.

One may use chlorine in the form of gas under pressure and there are special apparatuses on the market for the dosage. One may make the gas by electrolysis of salt water, or may use the commercial chloride of lime, also known as bleaching powder, which is made by the saturation of lime with the chlorine formed in the process of manufacture of caustic soda by the aforesaid electrolytic method. For practical purposes the chloride of lime has been found most useful, though there are certain definite advantages in the electrolytic chlorine.

Whatever the method by which the active agent is obtained, it is always the same, and is spoken of as available chlorine. Moreover, the active strength is also the same, as established by a large amount of experimental work, and as a result of this work one may say that a proportion of one part of available chlorine to one million parts of water will destroy all the germs of water-borne diseases. As the result depends on the action on organic matter as such it is clear that the amount of organic matter normally present in the water will have a bearing on the proper dosage, and that waters with a great variation in the organic content, as is true of our water here, will require a greater factor of safety than others.

*Paper read before Cleveland Engineering Society.

The fact of perhaps greatest importance is that there is apparently a critical point in dosage, at which satisfactory results will be obtained, but below which it is not safe to go. With the Cleveland water it was found experimentally, for instance, that 0.6 to 1,000,000 was adequate but that 0.5 was not. Moreover it is also true that a marked excess over this point is of no value as the total efficiency has already been obtained. Continuance of the experiments indicated that 0.7 allowed the necessary factor of safety, except under extraordinary conditions, when it will be advisable to make a temporary increase.

When the chlorine is put into the water where there is chance for aeration, as at the entrance to a reservoir, there is a very rapid action, and a very rapid disappearance of smell and taste, but where the circumstances are as in Cleveland, with the actual place of intake inaccessible during a large part of the year, this ideal method cannot be used. Accordingly it is necessary to put the chemical into the pump well, where there is an interval of less than five minutes before it goes under pressure. The killing effect has been satisfactory at this time, but the taste persists for a time dependent mainly on the temperature of the water, lasting longer in cold water, ordinarily from 30 minutes to an hour, while the odor persists practically until the water is released from pressure at the tap. The amount of odor will decrease with the increase of time from the intake and at distant points will be only appreciable by keen senses, while at nearer points it may be readily smelt, for instance, at the time of the morning bath. The actual disappearance is rapid, tests showing that when samples are taken at once and after five minutes there is already a decrease of nearly 50 per cent., and when the water reaches the consumer there is present less than one part in ten million, so high a dilution that to scientific men it is hardly necessary to point out the absence of danger.

Wherever the method has been tried, it has proved successful in reducing the water-borne diseases, and this has been notably the case in Cleveland, where at the time of introduction of the process, there were all the weather and water conditions suitable for the development of a serious epidemic, which, however, failed to appear. The typhoid rate in December has been the lowest for many years, though the general water conditions have been very unfavorable. In fine, the results of chemical treatment with chlorine have been found here and elsewhere to reduce typhoid to a very large extent and to reduce the pollution of the water as indicated by the daily tests at the city laboratory, which have been carried on since 1904, while there has been absolutely no positive evidence of the slightest ill results to persons who drink the water. The objections are in the main sentimental, and at times hysterical, but all the proof lies on one side of the case.

Note.—Cost of process. Apparatus for small communities pumping 200,000 to 500,000 gallons a day may be established for less than $25. Where there is a reservoir, very large quantities may be treated at a very low cost, and the only real expense lies in the establishment of the large tanks and the power mixer advisable for large communities. The cost of the Cleveland plant was $4,143.68.

The cost of the bleach is usually from $20 to $25 a ton, and roughly one-third of this represents the available chlorine. With the weight of a gallon as eight and one-third pounds one may calculate twenty-five pounds of the powder as able to disinfect one million gallons at a strength of one part in a million. From this the daily cost may be readily computed. Tests of the bleach should be frequent to check irregularities. The dosing outfit should be so arranged as to prevent the ingress of any of the sediment and should allow of flexibility in flow in case of changes in pumpage or in the quality of the water.

PURIFICATION BY OZONE.*

By R. M. Leggett.

One of the most convincing arguments in favor of our advanced civiliation lies in the fact that governments, both national and municipal, have taken to themselves the task of guarding the public health.

A sick or dead citizen ceases to be an asset to any community, and in a great many instances becomes a liability. The trend of modern medicine is to prevent disease, to teach people how to keep well, more than to make them well when stricken.

Thus, modern conditions place responsibilities upon cities that did not exist a decade ago. The city governments to-day are responsible, to a great extent, for the health and safety of every citizen. They supply an adequate police force to protect the public in so far as it is possible to do so, they provide asylums for the insane and hospitals for the sick, but so far as public health is concerned, a great many cities lock the stable door after the horse has been stolen. This they do by compelling the citizens to drink water containing sewage pollution and disease producing bacteria. To quote Ellice Hopkins, "It is better to fence the precipice at the top, than to wait with an ambulance at the bottom."

The majority of American citizens have learned by very bitter experience that it is costly to provide for their inhabitants a polluted drinking water.

Very rapid strides have been made by sanitary engineers in the last ten years, and their labors have resulted in placing at the disposal of cities various devices having as their object the purification of water.

Water purification embraces two principal acts, first, the removal of matter in suspension; second, the destruction of matter in solution.

Suspended matter comprises:

First—The grosses particles, such as clay, sand, leaves and parts of dead fish, sewage, etc.

Second—Micro-organisms.

Third—Bacteria.

The soluble content is composed of the organic compounds due to animal and vegetable decomposition, and mineral contamination from factories, and natural conditions of soil and rock.

In all problems of water purification, we have first to deal with that which causes disease, and after that, with those contents that cause unpleasant but harmless odors, colors and tastes.

The water to be treated by ozone must usually first be passed through a rapid roughing filter. This simply acts as a strainer, removing the grosser matter in suspension. Particles of sewage, dead leaves and organic matter absorb so much ozone, that if present in the water to be treated, reduce the efficiency of the system, unless first removed in this way.

(To be continued.)

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*Paper read before Cleveland Engineering Society.

Metallurgical Comment

T. R. LOUDON, B.A.Sc.

Correspondence and Discussion Invited

DROSS MELTING BY ELECTRICITY.

A new form of electric furnace for the melting of drosses, scrap metal and cyanide precipitates is described in the Brass World, January, 1912. This furnace is the invention of Raymond S. Wile, of the Pittsburg Electric Furnace Company, and is a combination of the arc and resistance furnaces. Four carbon electrodes are used, two passing up through the bottom of the furnace and the other two down through the top. When melting is to be begun, the furnace is partly filled with broken glass and the carbon electrodes arranged so that they touch. After the current is turned on they are drawn apart and an arc is formed, which soon melts the glass in its neighborhood. As the glass melts it becomes a conductor of the electric current, where before melting it was a non-conducor. The electrodes are now drawn farther apart so that the current passes through the molten glass and finally the whole charge becomes fluid, the glass being kept liquid by the resistance offered by it to the passage of the current.

When all of the glass is in a molten condition, the metal or dross to be melted is charged directly on top of it. The initial heat of the glass melts the metal, and then, on account of its great specific gravity and the fluid condition of the glass, it sinks to the bottom of the furnace where it is completely protected from oxidation. After several months the glass becomes more or less impure and must be tapped off and replaced, but broken bottles form a cheap mixture for refilling it. The furnace is lined with chrome brick, as that is found to be the best resisting material for such work. A furnace with a capacity of 1,000 lb. of brass will pour about one ton of metal per hour and, if run continuously, consumes about 68 kw. in doing so. If the current is not run continuously, and electric current costs 2c. per kilowatt-hour, it has been found that the current cost for melting 1,000 lb. of brass is about $1.36. This is somewhat higher than the cost of melting with oil or coke, but the waste in melting is less and is said to more than compensate for the extra power cost.

STRENGTH OF ROLLED ZINC.

When it was proposed recently that zinc be used for the hangers of electric cables the fact was brought out that data on the strength of American zinc were lacking, and tests were made by the Materials Testing Laboratory of the University of Illinois on this subject. Thin zinc plates were found to have an ultimate tensile strength of about 24,000 lb. per sq. in. The modulus of elasticity was found to average 11,500,000 lbs. per sq. in. Under the action of punches and shearing tools, zinc plates developed about 40 per cent. of the shearing resistance of mild steel and required the expenditure of about 30 per cent. of the energy required for plates of mild steel of the same thickness. No clearly defined elastic limit of yield point was found for cast or for rolled zinc. Zinc plates was found to break under pull with much less stretching than steel, but a zinc cylinder could be flattened without cracking. The result of tests of American zinc showed that its strength does not differ from that shown by European laboratories for foreign spelter. The results of these tests are published in Bull. 62 of the Engineering Experiment Station of the University of Illinois.

NEW COPPER ALLOY.

A copper alloy with the hardness of steel and great tensile strength is claimed by a French metallurgist. It is made by melting together one pound each of chromium and aluminum and adding 22 pounds of copper, 5 of nickel and 4 of zinc, with intervals of half an hour or an hour between the successive additions to the fused mixture. By varying the proportions of chromium and copper the alloy can be given a considerable range of properties, with adaptation to many uses.

WATER POWERS IN UNITED STATES.

On March 14th Herbert Knox Smith, United States commissioner of corporations, submitted to President Taft a report on the concentration of control over water power by large interests in important localities. The report recommends that the government should preserve title to the remaining power sites and develop them to prevent their possible monopolization by public utility companies. They should be developed at once, not only to conserve the fuel supply of the country, but also because they are rapidly passing into private control. The public can either develop and operate these sites, selling the energy at market rates, or lease the sites at a rental. Mr. Smith says that the water power developed and practically capable of development of this kind probably does not exceed 25,000,000 h.p. The total developed water power to-day is about 6,000,000 h.p. The total stationary power used in the United States, steam, water and gas, is probably more than 30,000,000 h.p. The enquiry showed that there was concentration of water powers in three distinct phases: first, there was concentration of control in each important locality; second, large interests influenced some of these local concerns, and finally, there was a growing relationship among large interests.

In California six corporations, of which the most important is the Pacific Gas & Electric Company, with 118,343 h.p., together control 375,000 h.p., which is over 80 per cent. of all developed water power in the State. In Washington two companies control 210,000 h.p., or about 70 per cent. of all developed water power. In South Carolina the Southern Power Company owns about 101,000 h.p., or 75 per cent. of the total development, with 73,000 h.p. undeveloped. In the southern peninsula of Michigan the Commonwealth Power & Light Company controls 52,000 h.p., or 73 per cent. of the whole commercial development, together with probably 71,000 h.p. more undeveloped. Practically similar conditions are reported to exist in Montana, Colorado and Georgia and at Niagara Falls.

More important than this local concentration are the operations of ten large groups of interests which possess control or influence over 1,821,000 h.p., about 60 per cent. of the water power already developed, together with 1,449,000 h.p. undeveloped. The General Electric interests are said to control or influence 939,000 h.p. of developed water power in eighteen States and 640,000 h.p. of undeveloped resources, a total of over 1,500,000 h.p. Next are the Stone & Webster interests with 278,000 h.p,. chiefly in connection with public service concerns. They exercise control over fifty-

five to sixty companies, largely through management rather than through ownership. Eight of these companies have water power.

The other groups are the Hydraulic Power Company of Niagara Falls, 144,000 h.p.; the Pacific Gas & Electric Company, with over 118,000 h.p. developed and the dominating factor in a large portion of California; the group known as the Clark-Foote-Hodenpyl-Hardy interests, 104,000 h.p., largely dominating the water-power situation in Michigan and also active in Maine and Oregon; the Southern Power Company, 101,000 h.p. in South Carolina, as previously noted; the S. Morgan Smith interests (Georgia), 76,000 h.p.; the Brady interests (Tennessee), 70,000 h.p.; the United Missouri River Power Company, 65.000 h.p., which, with the Butte Electric Power Company (General Electric group), practically dominates the power situation in Montana, and the Telluride Power Company (Colorado, Idaho and Utah), 56,000 h.p. The last-named nine interests also include under their influence 887,000 h.p. of energy as yet undeveloped.

The two greatest of the General Electric and the Stone & Webster groups have directors in a number of the same corporations. They and the S. Morgan Smith, Westinghouse and Brady interests are similarly connected.

OIL-DRIVEN TRAMS.

The Financial Times of February 23rd last gives an account of the recent developments in the use of oil fuel, and devotes particular attention to the recent trials of a petrol electric coach on the Great Western Railway of England.

The car, which was built for experimental purposes, weighs only 14 tons. The power is supplied by a 40 h.p. Maudslay petrol engine, which drives a dynamo, which in turn, transmits power to two electric motors on the axles of the rail car.

Notwithstanding the light weight of the vehicle, it accommodates 44 passengers, and this in itself is one great advantage of the petrol electric system, the weight of the car, engine, dynamo, etc., per passenger working out to only 700 pounds, as compared with about 1,500 pounds for the steam rail cars in use on the Great Western Railway.

A further advantage is that the fuel is contained in a very small area, the petrol tank, which is carried underneath the experimental car, holding sufficient petrol for between 200 and 250 miles running.

The car is divided into three compartments:—

(1) Containing petrol engine, dynamo and controller.

(2) Passenger compartment.

(3) Conductor's compartment, also containing electrical controller and brake control, the car being driven from either end, according to requirements.

Only one man is required at the driving end, the conductor riding at the opposite end and attending to the engine if required, he also being in a position to stop the car in case of emergency.

It is believed that the new system should prove, for the above reasons alone, in the case of small cars, considerably more economical than steam power, and with these advantages the further development of certain sections of the line which have hitherto not presented the likelihood of paying loads should be possible.

If the series of tests is satisfactory the Great Western Railway Company can hardly fail to reap the reward of their enterprise, as they are the largest users of rail motor cars in the United Kingdom.

ENGINEERING NOTES.

Montreal, P.Q.—The municipal engineer has taken objections to the plans of the Canadian Northern Railway for the construction of an underground tunnel on the grounds that he fears the excavations will damage the city reservoir.

Ottawa, Ont.—Engineers of the Public Works Department of the Federal Government are preparing to make a test in order to ascertain just how much the tower of the Victoria Museum has settled since the erection of the building. An effort is also to be made to ascertain the real cause of the sinking of the middle portion of the structure, if possible, and what means can be taken to prevent it in the future. During the past few months there has been no noticeable settlement, although it is feared that with the approach of spring matters may be different.

Vancouver, B.C.—The Vancouver Shipmaster's Association have disapproved of the plans for the Second Narrows bridge. They claim that with a strong tide running a slight delay in the opening of the draw would mean disaster for the marine interests and possibly for the bridge structure. The bridge has been designed in such a manner that the draw may be opened in three minutes. A design carrying the floor level higher than the one planned would please the shipping men.

PERSONAL.

Mr. R. C. St. John has been appointed to the position of engineer of maintenance of way for the Canadian Pacific Railway for Western Canada.

Mr. J. C. Holden has been appointed to the position of division engineer of the Canadian Pacific Railway for the Province of Manitoba.

Mr. C. H. Fox has been appointed to the position of assistant division engineer of the Canadian Pacific Railway for the Province of Manitoba.

MEETINGS.

Mr. G. R. Conway, chief engineer of the British Columbia Electric Railway, gave an illustrated lecture before the company section of the National Electric Light Association in Vancouver. He took as his subject "Famous Tunnels Under Rivers."

FAMOUS TUNNELS UNDER RIVERS.

During the course of an address given before the members of the company section of the National Electric Light Association in Vancouver recently, Mr. G. R. Conway, chief engineer of the British Columbia Electric Railway, stated that the teredo, a worm-like animal which perforates submerged woodwork, suggested the plan on which all subaqueous tunnel work is carried out. Marc Brunel in 1818 had his attention drawn to an old ship timber which had been bored by the teredo, and this led to an examination of the animal by the engineer. He found that the animal was armed with a pair of strong shelly valves, to which, with the foot used as a fulcrum, a rotary motion was given by powerful muscles, the wood being penetrated as by an auger. Brunel then invented his tunnel shield, which was a machine of iron forming auger-like cells for the workers, which was pressed forward with a rotary motion by hydraulic force, displacing the material for the tunnel. In this space.

as the shield moved onward, was placed a steel tube, which was later lined with brickwork. This method, based on the teredo action, the lecturer said, formed the foundation of all subaqueous tunnel work, even to the present day.

The tunnel under the Thames was started by Brunel in 1825, but not completed until 1842. During the progress of this work Lord Dundonald outlined an improvement in the methods involving the use of compressed air and air locks. Lord Dundonald's system was first used in the sinking of shafts at Chalons, France, in 1839 and in 1851 was employed in England on the sinking of the foundations for a bridge over the Medway at Rochester.

Views and explanations were then given of various great tunnel works, showing the advance of methods as the use of compressed air was improved, mechanical excavators employed, etc. These descriptions included the Blackwall tunnel, 27 feet in diameter, on which a shield weighing 200 tons was advanced 25 feet per week; the Baker Street and Waterloo tunnels under the Thames, each of 12 feet diameter, on which 29½-ton shields were used; the great River Dee tunnel, where a 400-ton shield was employed, and the tunnels of the Pennsylvania Railway at New York, where the North and East rivers are being conquered to provide adequate access to the city. This latter work was said to involve the construction of over six miles of tunnel of a diameter of 23 feet, on which four shields, each weighing 200 tons, were employed.

COMING MEETINGS.

CANADIAN INSTITUTE.—198 College Street, Toronto. Saturday Evening Lectures, 8 p.m. April 13th.—"Lantern Experiments on Reaction in Non-homogeneous Systems," by Prof. Kenrick, Toronto University. April 20th—"Chemical Interpretations of Vital Phenomena," illustrated. Prof. Leathes, Toronto University.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE CLEVELAND ENGINEERING SOCIETY.—Regular Meeting, Tuesday, April 9th, 1912. Chamber of Commerce Bldg., Cleveland, Ohio. Symposium on the Elimination of Grade Crossings. F. W. Ballard, Secretary.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary-Treasurer, R. W. Macintyre

QUEBEC BRANCH—Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—Secretary E. Brydone Jack. Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—Chairman, Geo. H. Webster: Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. V. Ross.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
4-8	Paving, Port Arthur, Ont. .....(S.)	3-21
4-11	Grading, sanitary sewers, cement walks, etc., Lethbridge, Alta.....(P. & S.)	3-14
4-15	Cement sidewalks, Battleford, Sask. ..(P. & S.)	4-4
4-30	Tunnel sewer, Edmonton, Alta. .....(S.)	4-4

(Battleford and Lethbridge plans and specifications are on file at The Canadian Engineer Office, 820 Union Bank Building, Winnipeg.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Calgary, Alta., concrete structures .....May 1.		Mar. 28.	70
Calgary, Alta., designs for aqueduct .....May 1.		Feb. 22.	70
Calgary, Alta., steel highway bridges .....Apr. 15.		Mar. 14.	68
Dorion, Ont., water pipe .....Apr. 3.		Mar. 28.	59
Fredericton, N.B., culvert, McKenzie Hollow .....Apr. 3.		Feb. 7.	89
Goderich, Ont., extension to breakwater and dredging ..Apr. 15.		Mar. 21.	70
Hamilton, Ont., concrete poles..Apr. 19.		Mar. 28.	59
Hamilton, Ont., water works extension .....Apr. 10.		Mar. 28.	72
Holland Island, B.C., lighthouse .....Apr. 20.		Mar. 21.	60
Lethbridge, Alta., grading, sanitary sewers, etc. .....Apr. 11.		Mar. 14.	70
Lion's Head, Ont., extension wharf .....Apr. 16.		Mar. 28.	60
London, Ont., cast iron pipe.....		Mar. 28.	72
Medicine Hat, Alta., church ....Apr. 12.		Mar. 28.	59
Moose Jaw, Sask., water-tube boilers, etc. .....Apr. 17.		Mar. 28.	59
Moose Jaw, Sask., supply of coal .....Apr. 13.		Mar. 21.	59
Ottawa, Ont., machinery for yard dipper dredge .....Apr. 9.		Mar. 28.	60
Ottawa, Ont., coal .....Apr. 10.		Mar. 28.	60
Ottawa, Ont., alterations to fuel testing building ..... Apr. 9.		Mar. 21.	60
Point Atkinson, B.C., concrete tower, etc. .....Apr. 20.		Mar. 21.	60
Point Grey, B.C., plans for university .....July 31.		Feb. 7.	60
Port Arthur, Ont., paving ....Apr. 8.		Mar. 14.	68
Saskatoon, Sask., pavement ..Apr. 5.		Mar. 14.	68
Sarnia, Ont., wharf and dredging basin .....Apr. 18.		Mar. 28.	60
St. John Harbor, N.B., dredging .....Apr. 9.		Mar. 28.	60
St. Boniface, Man., sewer .....Apr. 15.		Mar. 28.	60
St. Jerome, Que., hydro-electric installation.....		Feb. 7.	68
Sudbury, Ont., sewers, etc. ....Apr. 17.		Mar. 21.	60
Toronto, Ont., storm overflow sewer, Garrison Creek ....Apr. 9.		Mar. 21.	72
Toronto, Ont., dredging .....Apr. 3.		Mar. 28.	70
Toronto, Ont., concrete walks ..Apr. 19.		Mar. 28.	60
Vernon, B.C., C. I. manholes, frames, etc. .....Apr. 8.		Mar. 28.	60
Westmount, Que., cement, sand, etc. .....Apr. 3.		Mar. 28.	60
Winnipeg, Man., machine shop..Apr. 18.		Mar. 28.	60

TENDERS.

Battleford, Sask.—Tenders for the construction of a building for the Battleford High School Board, will be accepted up to April 6th, 1912. Plans and specifications at the office of Robert S. Byers, Architect, Saskatoon, or W. C. Soole, Secretary-Treasurer, Battleford.

Battleford, Sask.—Tenders for laying approximately 150,000 sq. ft. of cement sidewalk, with crossings and curbing, will be received by H. C. Adams, secretary-treasurer of the town of Battleford, up to noon of April 15th, 1912. Wm. Kitson, Town Engineer. (See advt. in Canadian Engineer).

North Battleford, Sask.—Tenders will be received by the Secretary-Treasurer as follows:—

(1) Until Monday, April 22nd, 1912, for constructing 180,000 sq. ft. of concrete walks.

(2) Until Tuesday, April 30th, 1912, for labor laying water mains and sewers. Also construction of power house.

(3) Monday, April 15th, 1912, for furnishing and erecting boiler; furnishing and erecting 750 h.p. steam engine and accessories; furnishing and erecting 500 k.w. generator and equipment. Plans and specifications may be seen at the office of the engineers, Toronto and Winnipeg, and at the Town Hall, North Battleford, on and after the following dates:—(1) April 3rd, 1912; (2) April 10th, 1912; (3) April 17th, 1912. J. Griese, Esq., Mayor; H. W. Dixon, Esq., secretary-treasurer; Messrs. Chipman & Power, engineers.

Carleton Place, Ont.—Tenders will be called for shortly for water supply, sewerage and sewage disposal works. Albert E. Crain, Mayor.

Edmonton, Alta.—Tenders will be received by the City Commissioners until April 30th, 1912, for the construction of a reinforced concrete tunnel sewer. Specifications and forms of tender may be obtained at the office of the City Engineer, Edmonton; also at the office of The Canadian Engineer. (See advt. in Canadian Engineer). A. J. Latornell, City Engineer.

Kentville, N.S.—Tenders will be received until April 15, 1912, for the erection of a brick and reinforced cement academy building for the town of Kentville, N.S. Plans and specifications at the town office, Kentville, or at the office of the Architect. J. Carroll, Town Clerk, Kentville. Leslie R. Fairn, Architect, Aylesford, N.S.

London, Ont.—Tenders will be received until May 1st, 1912, at the office of the City Clerk, for a modern 75-foot aerial hook and ladder truck, the apparatus to be delivered f.o.b., Central Fire Station, London, Ont., on or before August 1st, 1912. Tenders will also be received for bids on the old aerial truck, now in service, at the same time and date. W .D. I. Wright, Chairman No. 3 Committee. John Aitken, Chief, Fire Department.

Moose Jaw, Sask.—Tenders will be received up to noon of April 15th, 1912, for the delivery of sewer pipe and specials f.o.b. cars, Moose Jaw. City Commissioners. (See advt. in Canadian Engineer).

Moose Jaw, Sask.—Tenders for cast-iron pipe and specials will be received by the City Commissioners up to noon of Monday April 15th, 1912. (See Advt. in Canadian Engineer).

Moose Jaw, Sask.—Tenders for the supply and delivery of about 700 barrels of Portland cement, will be received by the City Commissioners, Moose Jaw, up to noon of April 9th, 1912.

Ottawa, Ont.—Tenders will be received until April 18th, 1912, for the construction of a reinforced concrete sewer at St. Boniface, Man. (See advt. in Canadian Engineer).

Ottawa, Ont.—Tenders will be received until noon of April 20th, 1912, for supplying and delivering the steam coal required for the fog alarm stations in the New Brunswick Agency during a period of one, two or three years at the option of the Department. Specifications, etc., can be obtained from the Marine Department at Ottawa, and from the agent of this Department at St. John, N.B. Alex. Johnston, Deputy-Minister of Marine and Fisheries, Department of Marine and Fisheries, Ottawa.

Ottawa, Ont.—Tenders will be received until May 1st, 1912, for the erection of additions and for certain alterations at the Mount Elgin Industrial School, Muncey, Ont. Plans and specifications may be seen at the office of the Principal, Muncey, and at the office of the Indian Agent, Dekaware, at the post offices, London, St. Thomas, and Hamilton, and at the office of J. T. Sing, C.E., Confederation Life Building, Toronto. J. D. McLean, Assistant Deputy and Secretary, Department of Indian Affairs, Ottawa.

Ottawa, Ont.—Tenders for the erection of a teacher's residence and a school-house on the Little Pines Reserve, Sask., will be received by J. D. McLean, Assistant-Deputy and Secretary, Department of Indian Affairs, Ottawa, up to noon of May 6th, 1912. Plans and specifications at the offices of the Indian Agent, Battleford; the Indian Agent, Duck Lake, and W. J. Chisholm, Inspector of Indian Agencies, Prince Albert; and the Indian Office, Winnipeg.

Penticton, B.C.—Tenders will be received until April 18th, 1912, for the erection of a concrete and steel power station, including all materials except as specified. Plans and specifications may be seen at the office of F. H. Latimer, Consulting Engineer, Engineer for the Municipality, Pentic ton, B.C., to whom all tenders may be addressed, and at the office of Mather, Yuill & Co., Consulting Electrical Engineers, 429 Pender Street, Vancouver, B.C.

Port Arthur, Ont.—Tenders will be received up to noon of April 15th, 1912, for the supplying and installation of a 50 box fire alarm system, with the necessary central station equipment. J. J. Hackney, Commissioner Utilities. (See Advertisement in Canadian Engineer.)

Prince Albert, Sask.—The time for opening tenders for Contract 12G for 2,400 lin. ft. of concrete outfall sewer disposal works, has been extended to noon, Monday, April 15th, 1912. C. O. Davidson, Secretary-Treasurer, Prince Albert. (See advt. in Canadian Engineer).

Regina, Sask.—Tenders will be received until noon of Friday April 12th, 1912, for the excavation of about three miles of trenching for and the laying therein of 6-inch to 15-inch vitrified pipes, construction of manholes, etc., for water collecting lines at the source of supply in the Boggy Creek Watershed near Regina. Plans, etc., may be had from R. O. Wynne Roberts, Consulting Engineer, P. O. Box 65, Regina. (See Advt. in Canadian Engineer).

Saskatoon, Sask.—Tenders will be received until noon, April 6th, 1912, for supplying cast-iron sidewalk gratings. All information may be obtained on application to Geo. T. Clark, City Engineer, Saskatoon.

Toronto, Ont.—Tenders will be received up to noon of Wednesday, April 10th, 1912, for the erection of the new entrance at Dufferin Street to the Exhibition Grounds, and also the erection of a combined fire hall and police station on the Exhibition Grounds. Specifications and plans may be seen and full information obtained at the office of George W. Gouinlock, Architect, Temple Building, Toronto. G. R. Geary, Mayor, Chairman Board of Control, City Hall, Toronto.

Toronto, Ont.—Tenders will be received until noon April 9th, 1912, for one 36-inch check valve for the waterworks department. Specifications may be seen and forms of tender obtained at the office of the City Engineer, Toronto. G. R. Geary (Mayor), Chairman of the Board of Control, City Hall, Toronto. (See Advt. in Canadian Engineer.)

Toronto, Ont.—Tenders will be received at the office of Symons & Rae, until noon, April 22nd, 1912, for all trades required in the erection of St. Alban's Cathedral, Toronto. Drawings, etc., may be obtained at the office of Symons & Rae, Superintending Architects, 15 Toronto Street. Cram, Goodhue & Ferguson, Architects, Boston and New York.

Winnipeg, Man.—Tenders will be received until April 9th, 1912, for the supply of a 50-h.p. gasoline traction engine, to be delivered f.o.b., city yards, on or before May 15th, 1912. Specifications, etc., at the office of the City Engineer, 223 James Avenue. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders are wanted for evaporating and bottling plant, at Little Lake, Manitou. Must be built before the first of May. Morrel's Manitou Mineral, Limited, Winnipeg.

CONTRACTS AWARDED.

Brampton, Ont.—Concrete reservoir; Mr. John Patterson; $3,600, and 30c. cubic yard for excavation. Tenders for pumps and meters have not yet been awarded.

Calgary, Alta.—A contract has been let at Edmonton for the construction of a sandstone brick plant to cost $100,000.

Chesley, Ont.—Public building; Messrs. Gilpin Bros., Wiarton, Ont.

Grand Falls, N.B.—Post Office and Customs interior fittings; the J. T. Schell Co., Alexandria, Ont.

Lockport, Man.—Approaches to bridge, Red River; the Brown Construction Co., Ltd., Winnipeg, Man.

Municipality of Surrey, B.C.—Erection of dams and excavation work; Messrs. M. P. Cotton & Co., Vancouver, B.C., $85,924, without gates.

New Liskeard, Ont.—Wharf; Mr. C. L. McCool, Fort William, Que.

Ottawa, Ont.—The contracts awarded for the Kent Street school alterations are as follows:—Carpenter and brick work, Taylor and Lackey, $9,113; galvanized iron work, Architectural Sheet Metal Company, $1,056; heating and plumbing, McKinley and Northwood, $3,373; painting and glazing, W. J. Carson, $925; fans, etc., Canadian Sirocco Company, Limited, $595; plastering, T. Brethour and Company, $400.

Port Arthur, Ont.—Office building for Alberta Land Co.; Mr. J. L. McRae; brick, two stories, 90-ft. x 110-ft.; cost, $62,000; Messrs. Hood & Scotte, architects.

Prince Albert, Sask.—Mr. Wm. Osemun, of Kinistino, has closed a contract with the C.N.R. for the grading of fifty miles of railway from Prince Albert towards Hudson Bay.

Stewart, B.C.—Extension to wharf, Portland Canal; W. G. Gillett, 429 Pender St. W., Vancouver, B.C.

Toronto, Ont.—Tenders on the construction of the Connaught Public School, amounting to $96,798, have been awarded as follows:—Masonry, Bayliss & Sons, $53,200; terra-cotta, Robert Bennett, $6,608; carpentry, William Williamson, $22,545; plastering, George White, $5,294; painting, J. R. Robinson, $2,630; roofing and tinsmithing, W. E. Dillon & Company, $2,021; iron stairs, Canadian Ornamental & Iron Company, $4,500. The total estimated cost of the Connaught School is $115,000, and work on which tenders are yet to be received are plumbing, heating, ventilation and wiring. The tender of the cabinet work in the manual training department of Brown School was awarded to the Beverley Wood and Specialty Company for $488.

Vancouver, B.C.—Messrs. Robertson, Godson & Co., Ltd., of Vancouver, have received the contract for the supply of water pipe for the proposed extensions to the water works distribution system, during the current year, at a contract price of $66,054. Other bidders and their prices are as follows:—Messrs. Crane Company, $68,643.50; Messrs. Evans, Coleman & Evans, Ltd., $68,443; Messrs. Balfour, Guthrie Co., Ltd., $68,837.50.

Victoria, B.C.—Messrs. Parfitt Bros. have secured the contract for the erection of an important addition to the emergency plant of the British Columbia Electric Company. They will erect a new cement roof and other fire-proof parts.

Welland, Ont.—Mr. Marcus Vanderburg, of Welland, has secured the contract for the extensive factory buildings at Port Robinson for the British-Canadian Canners, Ltd. The company will also build factories at Bowmanville, Cobourg, Merlin and Highgate.

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West Toronto, Ont.—The contract for the construction of tar macadam pavement from Humber bridge to Mimico at $10,000 per mile, has been awarded to the McKnight Construction Company.

Weyburn, Sask.—J. H. Simmons, of Winnipeg, has secured the contract for building a freight shed for Canadian Pacific Railway, to cost $25,000. T. Martin, Moose Jaw, Divisional Engineer.

Winnipeg, Man.—Messrs. C. W. Sharpe & Son have signed the contract for the new C.P.R. building at Edmonton to cost $350,000.

RAILWAYS STEAM AND ELECTRIC.

British Columbia.—Mr. William McNeill, chairman of the directors of the projected Burrard, Westminster, Boundary Railway and Navigation Company, has returned from Ottawa and is reported to have stated that ample capital for the commencement of the project has been secured and that the work will proceed at once if the provincial government show that they are in accordance with the scheme.

Calgary, Alta.—It is reported that the Chicago, Milwaukee and St. Paul Railway Company will construct a line from Butte, Montana, into Canada, and that part of the proposed route has been surveyed, and that it will pass through the Flathead Valley and into Alberta.

London, Ont.—The Water Commissioners have engaged the services of an expert to place a value on the plant and belongings of the London Street Railway with a view to purchase the same at a future date.

LIGHT, HEAT AND POWER.

Catineau Point, P.Q.—This municipality will construct a new system of electric lighting to cost $25,000. Mr. Lafortune is the mayor of this town.

Hull, P.Q.—The municipal council have stated that the funds available for the present will not permit the erection of a "white way" and if the same is constructed the citizens will have to pay for it themselves. Some members of the city council desire a movement made for aid from the provincial government of Quebec.

Sudbury, Ont.—Considerable damage was done to the plant of the Wahnapitae Power Company by the bursting of a turbine case.

Victoria, B.C.—The emergency power plant of the British Columbia Electric Company will be increased by the addition of about $25,000 worth of new apparatus, and extensions to the building. A new cement and fire-proof roof and other structural alterations will be made.

Victoria, B.C.—The city council have authorized the calling of tenders for the supply of cluster light materials.

GARBAGE, SEWAGE AND WATER.

Brighton, Ont.—The Reeve and Council of Brighton have instructed Mr. T. Aird Murray, of Toronto, to prepare plans for a gravity water supply for the town. The water will be taken from springs located north of the town.

Carleton Place, Ont.—The Board of Water and Sewerage Commissioners have completed an agreement with Mr. T. Aird Murray, of Toronto, to act as consulting and supervising engineer for works of water supply, sewerage and sewage disposal. The town recently passed a by-law for a sum of $150,000 for the above purposes. Tenders will be called for in the course of a month and the work proceeded with this year with as little delay as possible.

Cobourg, Ont.—The Town of Cobourg contemplates extensive additions to its sewerage system. Mr. T. Aird Murray has been engaged by the corporation to prepare plans for a system including sewage disposal for the western section of the town. The Northumberland and Durham Counties have also instructed Mr. Murray to at once prepare plans and specifications for a complete sewage disposal system for the House of Refuge. The work will be let by contract at an early date.

Edmonton, Alta.—The superintendent of the municipal waterworks has expressed his opinion in favor of the purchase of a duplicate of the large steam pump recently installed.

Lethbridge, Alta.—During the construction of the sewage plant it has been found that the estimated cost of $76,500 voted by the ratepayers will not complete the work, and that an additional $17,000 will be required. The total for the plant is made up as follows:—

Hotson, Leader & Goode's contract	$65,000
Roof for filters	7,000
For lifting sewage from No. 2 outlet to sewage plant.	2,000
Hauling 7,000 yards of cinders by city	10,000
Engineering, approximately	9,000
Total.	$93,000

Saskatoon, Sask.—The employees of the city have completed the task of constructing a new intake for the municipal water supply.

Saskatoon, Sask.—The date for opening of tenders for the outfall sewer and disposal work has been postponed until noon of Monday, April 15th. Geo. T. Clark, City Engineer.

Toronto, Ont.—The recommendations of Judge Winchester, who has been preparing a report on the water supply system of this city, include the purchase of Venturi meters to ascertain the loss between reservoir and main pumping station, a steel pipe to replace the cement one now in use, and that the pumping station be enlarged and electrical equipment be installed throughout.

BUILDINGS AND INDUSTRIAL WORKS.

Calgary, Alta.—Work is to be resumed immediately on the new million dollar store building for the Hudson Bay Company and an effort will be made by the contractors to have the building ready for occupation November 1.

Langdon, Alta.—The Canadian Pacific Railway will erect a dam at this point. The project is for the purpose of storing water for the irrigation system throughout the country around this town.

Lethbridge, Alta.—Mr. A. Southard announces that he intends to erect a six story hotel structure in this city. The cost of the undertaking will be about $300,000. The building will contain 200 rooms and be constructed of brick and terra cotta.

Ottawa, Ont.—A new company which will be known as the Gatineau Spa Milling Company, composed of prominent business men of Ottawa and Hull, is in process of formation. The company which is capitalized at $125,000, has acquired quarries situated in the Gatineau Valley. Messrs. Belcourt and Ritchie are engaged in organizing the new industry.

Port Arthur, Ont.—The ratepayers of this city will erect a new municipal hall to cost $100,000. The Central School site has been chosen for the structure.

Regina, Alta.—The Security Lumber Company plan to erect lumber yards and sheds in this city. The head office of this concern is in Winnipeg, Man.

Saskatoon, Sask.—An addition to the programme of large buildings for the coming season has been made owing to the announcement of Messrs. S. R. and W. Ross of their intention to erect a seven story structure for office purposes in this city. The building will contain one hundred and forty offices and will be fitted with all modern conveniences for mercantile pursuits.

Saskatoon, Sask.—There is serious talk of the municipal controllers taking definite steps toward the construction of a civic abattoir. Ald. Maclean and Blackstock are the committee that will report on the project.

Saskatoon, Sask.—Messrs. Harrison and Jones, brick manufacturers, England, are about to consider the erection of a brick plant in this city. Mr. Charles R. Hill, Saskatoon, is interested in the matter.

Welland, Ont.—Mr. J. L. Weller, superintending engineer of the Welland Canal, reports that it is the intention to sink large steel tubes underneath the canal at the north end of the aqueduct, from the river above, where the present lock is, to the river below the aqueduct and change, for that distance, the bed of the river, carrying it through these tubes instead of underneath the aqueduct as at present.

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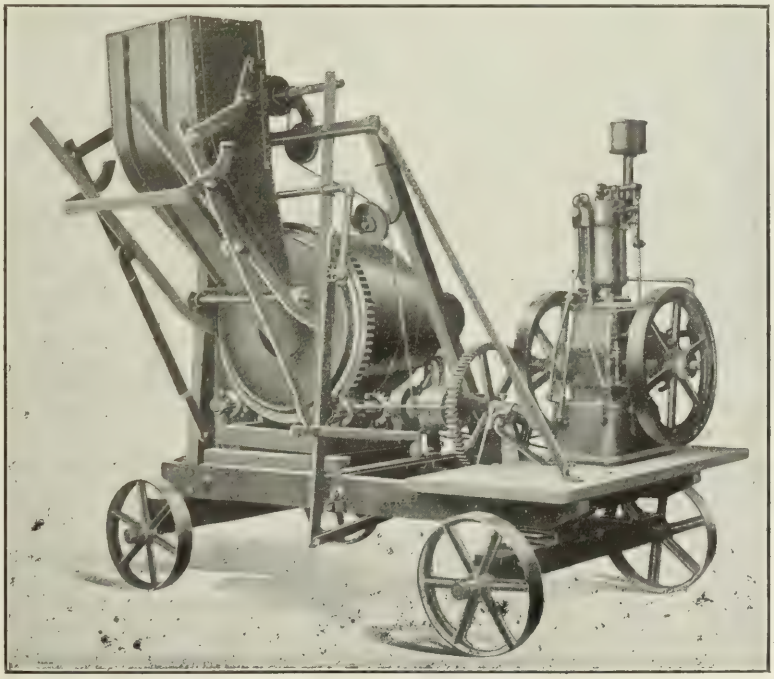

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BRIDGES, ROADS AND PAVEMENTS.

Brantford, Ont.—The Grand Trunk Railway officials are considering the rebuilding of the bridge over the Grand River at a cost of $50,000. The proposal is to move the easterly abutment eighteen feet farther east and add a span at the west end of 68 feet 6 inches. Also to rebuild the centre part with two trusses and another girder. The old bridge consists of three spans of 100 feet each, having a clear water way of 285 feet. The clear water way of the proposed bridge will be 366 feet. To get this will mean the building of two new abutments, and three piers, the westerly abutment being turned into a pier.

Gatineau Point, P.Q.—The Provincial Government of Quebec Province have sanctioned the expenditure of $20,000 for the construction of macadamized roads around and in this locality. Mr. Lafortune is the mayor of this town.

Galt, Ont.—A proposal has been made that the present bridge doing service on Main Street of this town be moved below the waterworks and provide an entrance to the industrial section.

Halton County, Ont.—The Halton County Council propose to spend $300,000 on road improvements in their county. This includes the grant recently made by the government. n ent.

Kildonan, Man.—The council of this municipality are considering the erection of a bridge to cost $165,000.

Province of Manitoba.—Premier Roblin, during a discussion on the estimates in connection with grants to the various municipalities of the province in aid of roads and bridges, stated that at the present time the government was considering a policy of having a standard road for the province, and also of bringing in a bill at this session defining the position to be taken by the government on the important question of good roads.

Nelson, B.C.—Chief Provincial Engineer Griffiths will advocate that the proposed bridge across the Kootenay River at Nelson be a quarter of a million dollar steel and concrete structure instead of the pile bridge originally planned. A permanent bridge is necessary to meet the rapidly growing requirements of this district.

Saskatoon, Sask.—This municipality will purchase six new road sprinklers during the coming spring. Geo. T. Clark, city engineer.

South Vancouver, B.C.—The municipal council will consider a new by-law dealing with the collection and handling of the civic garbage. It is proposed to fill certain ravines and gullies around the city with the refuse.

St. John, N.B.—The Provincial Government has announced that an agreement has been reached with the St. John Railway Company with regard to the erection of a bridge, to cost $335,000.

FIRES.

Lindsay, Ont.—Fire destroyed the plant and premises of the Hood Knitting Company.

Oshawa, Ont.—The car barns of the Oshawa Railway Co. were destroyed by fire on the morning of March 29th last. The loss is placed at $20,000.

Ottawa, Ont.—The plant of the Ottawa Paint Works was destroyed by fire on March 28th, last. Loss estimated at $8,000.

Orillia, Ont.—The sash and door factory of J. R. Eaton and Sons was destroyed by fire on March 27th last.

CURRENT NEWS.

Lethbridge, Alta.—Tenders will be called at an early date for the work of laying and constructing the municipal sanitary sewers, street grading and cement sidewalks.

Calgary, Alta.—The Canada Western Natural Gas, Heat, Light and Power Company will lay their underground mains by means of a mechanical trencher with a capacity of one mile, six feet deep and twenty-two inches wide, per twenty-four hours. The digging pieces or buckets are caused to pass along in rotation, each grasping its capacity of earth or gravel and in turn depositing it on a wooden slide that passes it out to one side. The digging part of the machine, which gets its power from a 24 horsepower gasoline motor, is similar to that of many river dredges.

Frank, Alta.—The Canadian Pacific Railway will confer with the federal authorities for the making of an expert's report on the advisability of blowing up Turtle Mountain at Frank.

Moncton, N.B.—The natural gas piping is now completed in this city the first users of the commodity being Messrs. John Abram and Sons. This firm will use the gas for boiler operations as soon as the necessary appliances are installed.

Montreal, P.Q.—The Shipping Federation and the Montreal Board of Trade have petitioned the federal government that the wrecking plant of the Messrs. George T. Davis and Sons, of Levis, P.Q., be granted an increased subsidy and the plant retained in its present position on the St. Lawrence River for an emergency. There has been some talk of a sale being concluded with the owners and another shipping firm. The proposition will be considered by the cabinet.

Moose Jaw, Sask. — Money by-laws totalling $741,000 have been passed by the ratepayers. They include $95,000 for 11th avenue subway; $225,000 for electric plant extensions; $70,000 for public library; $170,000 for sewer and water extensions; $6,000 for exhibition ground improvements; $16,000 for the paving programme. An option was also given of $15,000 or $10,000 grant for the board of trade campaign, and the former carried. All the by-laws had sweeping majorities.

Quebec, P.Q.—The federal government are preparing plans for an increased wireless telegraph equipment at this point. The present station in the Citadel is only a half-kilowatt one, and it is impossible to get communication with Father Point, or Montreal, without relaying at the stations at Grosse Isle or Three Rivers. The new station will be one of five kilowats, or perhaps ten, so that direct communication will be established with places hundreds of miles distant.

Regina, Sask.—The municipal council are about to appoint a Health Officer for the city.

Vancouver, B.C.—This municipality recently witnessed the working of a new system of fire alarm methods. Representatives of the manufacturers fitted up a working model and invited fire insurance inspectors, electricians and business men to the demonstration. The great point of difference with the systems now in use is that the ordinary civic telephone wires are the main part of the new apparatus. A small signal box is connected with the house instrument in such a method as to not interfere with the workings of the telephone. At the fire station end of the system the usual signal boards are used and should a fire occur in a building a contact button is pressed on the cover of the box, a buzzing sound in the central exchange warns the operator that the attention of the fire station is requested and she connects the telephone in the burning building with the fire station and saves the time of an ordinary call.

Vancouver, B.C.—A report states that a number of British and French financiers have decided to promote a scheme for building a floating dry-dock for Vancouver. The capital for the scheme has already been subscribed, and joint boards have been formed in London and Paris in connection with the project.

Vancouver, B.C.—The mayor of this municipality has decided to make a tour of the city and fix the blame for the condition of the dirty streets and lanes that exist in some portions of the city. As there appears to be some difference as to the share of responsibility held by the health authorities, the police and the fire warden, as well as the Board of Works, the mayor considers that a joint tour will do a great deal to clear the matter up and effect more co-operation.

West Vancouver, B.C.—There has been a movement made to appoint a city engineer for this municipality. Applicants may address the clerk of North Vancouver.

The smelting of metallic ores in Canada during 1911 did not produce the profit that was enjoyed from the same industry in the year 1910. The following list has been com-

THE TRIPLEX BLOCK

A Triplex Block hung from a temporary rigging and used for laying pipe.

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CALGARY SASKATOON VANCOUVER VICTORIA

piled from the mines branch of the Dominion Government at Ottawa. The ores treated may be classified as follows:

	1910, tons.	1911, tons.
Nickel-copper ores	628,947	610,834
Silver cobalt-nickel-arsenic ores	9,466	8,504
Lead and other ores in lead furnaces	57,549	55,408
Copper-gold-silver ores	1,987,752	1,517,981
Total	2,683,714	2,192,727

The closing down of the Granby smelter in British Columbia, due to the coke shortage, was the principal cause of the falling off in copper-gold ores treated.

The products obtained in Canada from the treatment of these ores include: Refined lead produced at Trail, B.C., and fine gold, fine silver, copper sulphate and antimony produced from the residues of the lead refinery; silver bullion, white arsenic, nickel oxide and cobalt oxide produced in Ontario from the Cobalt district ores.

TRADE ENQUIRIES.

The following were among the enquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending March 11th, 1912:—

An English firm of fancy leather dressers are desirous of getting into touch with Canadian importers and users of bookbinding and fancy leathers.

A London firm manufacturing electrotyping machinery and appliances, elevating laying machines, box board printing machines, branding machines, box trimming and nailing machines, stereotyping machinery and appliances, desire to get into touch with Canadian importers.

An East Anglian firm specializing in the manufacture of cement-making plant desire to enter into Canadian business connections.

The following were among the enquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending March 18th:—

A Bristol correspondent makes enquiry for the means of Canadian furniture manufacturers open to establish themselves in his city.

A Yorkshire firm manufacturing elevators and conveyers for grain, coal, and all classes of material, as well as complete equipments for colliery surface plants, and specialties connected with automatic stoking and transport appliances, desire to get into touch with users of such machinery, and to appoint suitable representatives in Canada.

A London firm desire to appoint agents in Canada for the sale of their high-class decorative enamels and iron enamels.

A London firm manufacturing annealed tungsten wire lamps for steamships, piers, quays, cotton mills, etc., desire to get into touch with Canadian importers.

A correspondent now in London is proposing to establish in South Africa a general agency for Canadian goods of all descriptions, for which a large market exists, and would like to hear from Canadian manufacturers and produce exporters open to consider propositions.

An Indian firm of manufacturers and general agents desire to get into touch with Canadian manufacturers and produce exporters open to do business in India; also with importers of Indian products.

From the branch for City Trade Enquiries, 73 Basinghall Street, E.C.:

A South of England company manufacturing bungalows and all kinds of portable buildings would like to arrange for their sale in Canada.

A Lancashire manufacturer of belting (leather, cotton, balata, etc.,) would like to be placed in communication with Canadian importers.

A manufacturers' agent in Toronto asks to be placed in touch with United Kingdom manufacturers of bifurcated, tubular and other rivets of all kinds, and also self-feeding automatic machines for attaching same; leather measuring machines and manufacturers of belting, and garter elastic.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16135—March 14—Approving changes and alterations in C.P.R. station at Dufferin Bridge, Ottawa, Ont.

16136—March 15—Relieving C.P.R. from erecting and maintaining fences on its Sirdar subdivision, B.C.

16137—March 15—Authorizing C.P.R. (G.B. & S. Ry.) to cross two highways at mileage 82.89 and 82.02.

16138—March 18—Authorizing C.P.R. to reconstruct bridge No. 66.6 on Souris subdivision.

16139—March 18—Authorizing C.P.R. to construct spur track across Montcalm Street, in the city of St. Boniface, Man.

16140—March 18—Authorizing C.P.R. to construct industrial spur for city of Medicine Hat, Alta.

16141—March 18—Permitting C.P.R. to file a new location plan for its Molson St. Boniface branch, said plan to show a width of land that will coincide with arbitration notice filed by the railway company; application of E. B. Chambers and W. G. Phair, Winnipeg, Man.

16142—March 16—Approving revised location of C.N.R. (Swift Current Branch) mileage 78.29 to 124.56, Saskatchewan.

16143—March 16—Relieving G.T.R. from further protection of 2nd highway north of Huntsville, dist. of Muskoka, Ont.

16144—March 19—Further extending until April 1st, 1912, time for installation of interlocker at Nipissing Jct. by G.T.R. crossing C.P.R. and connecting with T. & N.O.

16145—March 20—Directing that Twp. of York shall at all times maintain bridge over Toronto Belt Line Ry. (G.T.R.) east of Yonge St., Toronto, as well as construct same.

16146—March 19—Authorizing C.P.R. to construct bridge 85.2 on its Portal subdivision, Sask.

16147—March 18—Naming express delivery and collection limits for city of Ottawa, Ont.

16148—March 20—Substituting Plan "A" for plan filed showing diversion C.N.O. Ry. approved by Order 13052, June 14, 1911.

16149—16150—March 20—Authorizing G.T.R. to construct siding for J. Goodwillie & Sons, Welland, Ont., and for J. T. Watson, in the Township of York, on Toronto Belt Line Railway.

16151—March 20—Authorizing town of Claresholm to extend Fourth Ave. across C. & E. Branch of C.P.R.

16152—March 21—Authorizing C.P.R. to reconstruct bridge No. 176.9 over Bow River on Calgary Sub-division.

16153—March 18—Rescinding Order No. 12783 on Jan. 18th, 1911, in complaint Dawson Board of Trade vs. White Pass & Yukon Route.

16154—March 22—Authorizing C.P.R. to construct its Lacombe Easterly Branch across highways from mile 140.31 to 143.61.

16155—March 22—Relieving C.P.R. from further protection at public highway near Griswold, Manitoba.

16156—March 21—Authorizing C.P.R. to construct spur for Vancouver Lumber Co., Ltd., in Townsite of Merritt, B.C.

16157—March 22—Authorizing C.N.O. Ry. to construct spur for Alexander Bruce and Company. Tie Preserving Plant, on Indian Reserve No. 18B in Twp. of McIrvine, Ontario.

16158—March 20—Approving rules of T.H. and B. Ry. for operation of automatic block signals.

16159—March 22—Approving location of Campbellford, Lake Ont. and Western Ry. Co., through town of Oshawa and revised location as previously approved by Order 11947 through Township of East Whitby mileage 29.1 to 34.2.

16160—March 22—Authorizing Montreal and Southern Counties Ry. to construct track from G.T.R. property east of Front St., St. Lambert, P.Q., to connection with Central Vermont Ry., crossing Victoria Ave. by overhead bridge.

16161—March 21—Directing G.T.R. to file special tariff or supplement to existing tariff C.R.C. No. 1686 to take effect not later than 8th April, 1912, establishing a rate of $3.00 per car for switching lumber from docks of F. McGibbon and Sons, of Sarnia, Ont., to storage yard and mill, for storage, sorting or dressing and re-shipment via. G.T.R.

16162—March 21—Authorizing G.T.R. to construct siding to premises of William Laking at Haliburton Sta., County Haliburton, Ont.

16163—March 22—Directing G.T.R. to at once remove shrubs, etc., at crossing of 1st highway east of Waterdown Station, Ontario. Cars of trains not to be left standing within 75 feet of crossing.

16164—March 20—Approving standard plan of Portable Depot of Great Northern Railway Company.

16165—March 25—Naming express delivery and collection limits for city of Hull, Que.

10166—March 22—Authorizing G.T.R. to construct spur into premises of Steel and Radiation, Ltd., St. Catharines, Ont.

16167—March 23—Authorizing Highway Board of Parish of Grand Falls, N.B., to construct highway across C.P.R.

16168—March 23—Approving location of C.P.R. Suffield to Kipp, Alta. Branch from main line near Suffield to mileage 21.

16169—March 13—Authorizing C.P.R. (G.B.&S.Ry.) to construct across Jackson Street, in village of Bethany, Ont.

16170—March 5—Approving location of G.T.P.Ry. station to be erected at Henry House, Alberta.

16171—March 25—Approving Supplement No. 8 to Express Classification for Canada No. 2.

16172—March 25—Granting certificate of correction to G.T.R. B.L. Co. correcting errors in revised plan at Cutknife Branch.

16173—March 25—Slightly amending Order No. 16076 March 5th, 1912, re Boissevain to Lauder Branch of the C.P.R.

16174—March 23—Authorizing city of Saskatoon to carry 20th Street across C.P.R. at Rail Level.

16175—March 25—Amending Order 16064 of March 1st, 1912, re Bridgeburg Bridge by adding clause that Municipality shall at all times and at its own expense maintain bridge, etc.

16176—March 26—Authorizing G.T.R. to construct bridge No. 165 at mileage 32.22 over Clubiness Creek and Bridge No. 166 at mileage 33.91 over Holland River, 11 District Northern Division.

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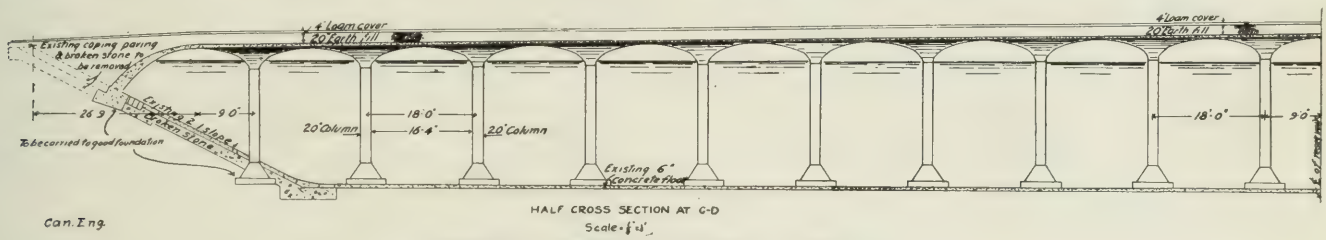
An Engineering Weekly

MINNEAPOLIS MECHANICAL WATER FILTRATION SCHEME.

By A. W. ELLSON FAWKES, C.E.

The Minneapolis mechanical water filtration scheme is now nearing completion, which will fill a long-felt want as regards the city's water supply. In the early stages Minneapolis had under discussion two projects, i.e., mechanical water filtration, and piping of the water from Mille Lacs, a distance of eighty-one miles. The vital points were: pure water, quantity, description of project, and cost.

The present average consumption of water in Minneapolis is twenty million gallons with a population of 316,000, with a per capita consumption of sixty gallons per day, quite a low figure at a glance, but a study of the analyses of the Mississippi water is explanatory. On account of the evaporation, run-off, and shrinkage of the water on Lake Mille Lacs, also the estimated cost of $3,913,414, approximately $48,915 per mile, the Mille Lacs scheme was abandoned in favor of the mechanical filtration scheme, by this means utilizing the existing pumping stations with an increased pumping capacity of 80,000,000 gallons per day.



Section Through Clear Water Reservoir.

The mechanical filtration system having been decided upon, various analyses of the water were taken to determine the extent of the mechanical scheme. Briefly the water of the Mississippi River contains:

Chemical analysis (sanitary)—Free ammonia, alb. ammonia, chlorine, alkalinity, hardness.

Physical analysis—Suspended matter, (a) mineral, (b) organic; rate of sedimentation, color, suspended and dissolved matter, (a) organic, (b) inorganic.

Biological analysis—Bacteria, plankton.

Mud analysis—Mineral, clay, silica, organic (dead and living.)

Chemical Analysis.—Free albumnoid and ammonia varies from .430 in May to as low as .059 in October.

Alkalinity and permanent hardness: The average total hardness reached a maximum of 173 and a minimum of 139. The maximum is during the months of December, January, February. The minimum during April.

Chlorides: These vary greatly with the heights of the water, and follow directly the alkalinity and total hardness. During the past ten months the chlorides have varied in about the same relative amount as the permanent hardness.

Color: The Mississippi River varies greatly in color at different points along its course. These changes in color are caused by the confluence of contributary streams. Along some of the highly-colored tributaries are large swamps, the water of which shows a color as high as 700 to 800. This color is derived from macerated vegetable matter, and persists as a considerable factor in the total color of the Mississippi at Minneapolis. The greatest reduction of color occurs during the months of August and September, and very little in the winter. This is coincident with the greatest and least amount of plankton. When copper-sulphate was used to destroy plankton, the bleaching process at the reservoirs was interfered with.

Suspended and dissolved matter: The organic residues are greatest in summer months. The inorganic residues follow the alkalinity and chlorides. The mineral residue varies from 113 to 162. The organic from 62 to 75.

Turbidity: The turbidity of the Mississippi River water at Minneapolis is usually low—so low, in fact, that it has been regarded as a negligable quantity in the earlier analysis. In occasional instances it has for a short time risen to 25 or 30, but quickly subsides. It is safe to assume that in 350 days of the year it is in the neighborhood of 10.

The Mississippi water deposits on an average .13 cubic yards of sediment per million gallons of water during a period of four days of sedimentation. In the process of sedimentation, the algae and diatoms are the first to be deposited; at the end of 24 hours, only fine clay remains suspended in water, and at the end of 96 hours but 36% of the original turbidity remains.

The following is an analysis of deposited matter taken from the city reservoir recently:

Organic matter	19.3%
Alumina	13.6%
Silica	50.3%
Iron (ferric-oxide)	6.5%

The most objectionable feature of the Mississippi River water at Minneapolis is the bacterial content. Colon bacilli are constantly found in the water. This indicates the presence of animal contamination. The high rate of typhoid

fever in Minneapolis among the users of the river water of the Mississippi goes to prove this. The fact that typhoid bacillus has been isolated from the waters of the Mississippi at Minneapolis, and the fact that above Minneapolis are situated several large towns contributing sewage directly into the river indicates the dangerous character of the raw Mississippi River water. It has been stated by engineers that typhoid fever germs will live in the same water for ten days. The Mississippi water passes several towns, such as Grand Rapids, Anoka, St. Cloud, Little Falls and Brainerd. The water that passes these towns reaches Minneapolis in less than eight days. The contamination of the Mississippi at Brainerd is sufficient to give colon bacilli in every cubic centimetre of the water throughout the course of the stream. The absolute numbers of bacteria in the

Reinforcement of Groin Arches North Filter Basin, and forms to South Series of Filter Built in Alternate Sections.

water at Minneapolis vary according to the season; the greatest in July and August was 3.000 per c.c., and lowest in January 150 per c.c.

The greatest percentage of reaction occurs in the reservoir also during July and August. These are the months of the maximum of plankton, when the range is from 400 to 1,200; in January 75 is an average.

Softening the Water.—The alkilinity of the Mississippi River water is due to the bi-carbonates of calcium and magnesium. This means the presence of carbon dioxide gas (Co 2). To reduce the alkilinity of the Mississippi water to about normal (66) after a treatment of 24 hours will be possible with lime treatment in about the quantities of 7.26% grains per gallon of raw water during November and December.

Color.—The color is due to vegetable substance which is slightly lessened by the lime treatment, and is further treated by alum as a bleaching medium. The slight precipitation soon settles with two grains per gallon, assisted with four grains of sulphate of aluminum. The Mississippi water will continue to bleach with longer storage.

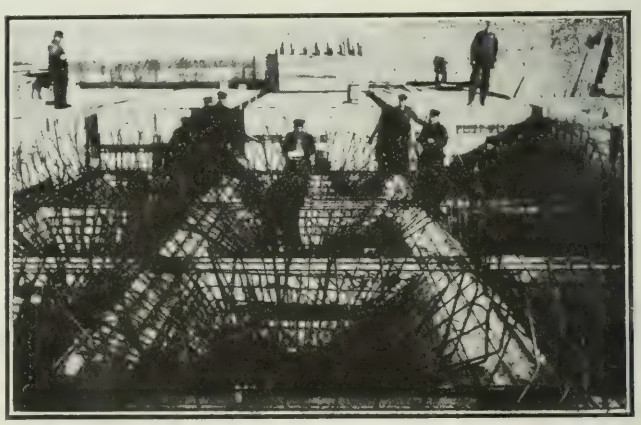
Sterilization.—The water in the reservoirs: 90 million gallons was treated with copper sulphate (50 lbs. to the 90 million gallons three times a week, and as a result the plankton was decreased 80% in 30 days. Bacteria was reduced 40%, turbidity 20%. Also the color was slightly reduced. These experiments were conducted during July and August, the usual time for these organisms to be on the increase.

The purification of the Mississippi River water having been solved, and the amounts and kind of purifying mediums to be administered, the constructional part of the work was started late in the fall of 1910, and has progressed very rapidly. The work was done on the day labor plan, the city of Minneapolis being the contractors.

The layout of the plant is as follows: The raw water or settling reservoir is of concrete and has a capacity of 75 million gallons. The water passes from this reservoir after sedimentation into a 60-inch intake pipe through a venturi meter into the chemical controlling chamber. There it receives the chemical treatment, measured by automatic devices according to the flow of the water. The water then passes into the mixing chamber, and is thoroughly mixed by flowing around a large number of wooden baffles. It then passes through controlling chamber No. 2 into a centre passage and is distributed into the two coagulating basins, again flowing against baffles, then passes over a skimming weir into the upper portion of the centre passage through a 60-inch influent pipe passing through the south side of the head house into the pipe gallery. The water is then passed into the filters ranging along each side of the pipe gallery through 24-inch branches off the influent pipe. The water passes through the filters into a network of pipes below, through a controlling meter into the clear water basins below, there to be turned into the large covered reservoir with a capacity of 47 million gallons, or into the city's distributing mains.

Head House.—The head house is of concrete and brick construction with several floors, and contains the mechanical devices for the operation of the plant. At grade 300 are located the two boilers for heating purposes, having a heating capacity of 15,000 square feet.

Alum Tanks.—These tanks are of concrete, reinforced with ¾-inch rods, both vertical and longitudinal. They are 13 ft. by 12 ft. by 12 ft. high. The concrete in these tanks was a 1:2:4 mix, and was put in for $7.00 per cubic yard. Above these tanks are located three 3-h.p. motors to drive the agitating devices. There are two pumps in connection with these alum tanks of the single section type, with a two-inch discharge having a pumping capacity of 40 gallons per minute against a 45-foot head including friction. They



Reinforcement of Concrete Storage Bins.

are operated by two single 2-h.p. motors. These pumps have bronze shells, runners, and diffusion vanes, and monal-metal shafts with especially designed packing to resist the action of the acid solutions. Switches for controlling these pumps are connected with the operating room at a point convenient to the pumps.

Hypo Tanks.—These tanks are similar to the alum tanks in construction, except that they have a concrete cover over them. The motive power, pumps and controlling devices are the same as in the alum arrangement.

Lime Tanks.—These tanks are of steel plate construction, three in number, 12 ft. 6 ins. in diameter and 13 ft. high. They have an agitating device driven by three 5-h.p. motors. There are two lime solution pumps in connection with these tanks of the single suction type with a 3-inch discharge especially designed for a 7% solution and pumping a thick, gritty liquid. They have a pumping capacity of 40 gallons per minute against a 45-ft. head. These pumps are also operated and controlled at the operating room as well as at the tanks, and are driven by two 2-h.p. motors.

Mixers.—There are two concrete mixers with a mixing capacity of 40 cu. ft. each for mixing the lime solution which is dumped into a trough in front of the tanks and flows through a screen of a ¼-in. mesh into the lime tanks. These mixers are driven by two 20-h.p. motors. The floor at grade 300 is sloped to a grade of 1 in 20 to drain the floor to a sump. In this sump is placed a vertical submerged pump with a pumping capacity of 200 gallons per minute against a 15-ft. head, and a suction of six feet. It is slow speed and automatic in operation. The pump and motor have a combined efficiency of 35% driven by a 3-h.p. motor.

Wash Water Pumps.—There are two of these pumps of the single stage centrifugal type with an eight-inch discharge, having a capacity of 1,600 gallons each per minute against a 50-foot head. These pumps are for the purpose of feeding the wash water tank with water to wash the filters. The water is taken from the clear water basins as it is necessary to wash with filtered water. Upward wash is used, the wash water flowing into the drain provided. These pumps are intermittent in action and are each controlled with an electrical controlling apparatus which will automatically stop when the water reaches a certain elevation in the wash water tank. These pumps are driven by two 40-h.p. motors.

Flushing Pumps.—These pumps are of the two-stage, 50-h.p. centrifugal type, with a pumping capacity of 500 gallons per minute when flushing, and operated against a pressure of 100 lbs. per sq. in. They are driven by a 50-h.p. motor.

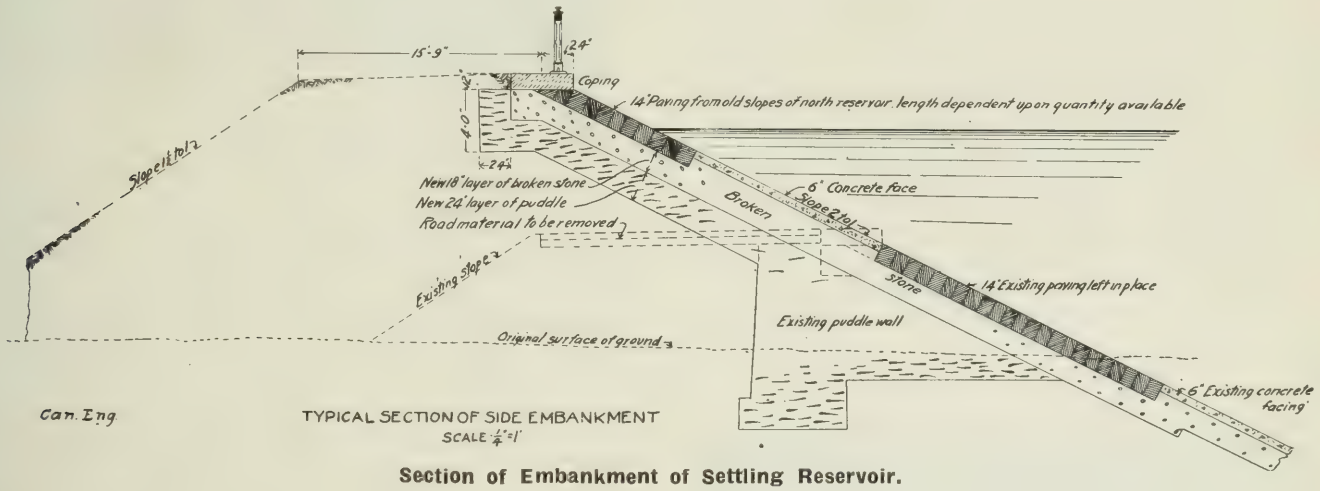
Pressure Tank Pumps.—These pumps also take water from the clear water basins and deliver water to a small steel tank in the tower of the head house. They are of the single suction type, discharging 30 gallons per minute against a head of 80 feet. They are operated by two 3-h.p. motors. These pumps are intermittent in service and are started and stopped by means of floats placed in the tank. Each float operates a Cutler Hamar series relay self-starter. It starts and stops the corresponding pump with a positive and certain maximum difference of not over six inches in the rise and fall of the water in the tank.

Sample Pumps.—There are twelve of these pumps of ¼ h.p. each with a pumping capacity of two gallons per minute against a 20-ft. head. These pumps are situated on brackets secured to the walls of the operating gallery, one under each of the 12 operating tables. They take their suction from the corresponding influent pipes near the filter gallery wall, and are controlled by switches on the corresponding table.

Lime Crusher.—The lime crusher has a capacity of 15 tons per hour, the crushed lime to pass through an iron ring of one inch in diameter.

Concrete Storage Bins.—These bins, twelve in number, are for the purpose of storing the alum, lime and hypochlorite. The various chemicals are conveyed from these bins by a bucket with a recording gauge to register the weight. The bucket travels along a suspended track to the lime, alum and hypochlorite tanks. The concrete to the storage bins is heavily reinforced with steel work. The concrete was of the 1:2:4 mix and cost $9.00 per cubic yard. The forms to this work came rather high, averaging 9 cents per square foot.

Chemical Feed Tanks.—These tanks are situated on floor grade 328, and consist of the lime, hypo. and alum



Section of Embankment of Settling Reservoir.

water, and are controlled by a set of lime, alum and hypo. controllers.

The offices, laboratories, preparation rooms, lockers, lavatories and bath rooms are on this floor grade 328.

Ash Storage.—The ash storage is located on floor grade 340.

Controlling Chamber.—This chamber is 28 ft. by 7 ft., in which is situated a venturi meter to gauge the flow of the water from the raw water basin. The chemical supply is admitted at this stage, controlled and governed by a device in connection with the venturi meter. The controlling chamber and venturi meter is of concrete.

Mixing Chamber.—This chamber is 141 ft. by 47 ft., is connected to Nos. 1 and 2 controlling chambers, and is divided into 47 spaces by wooden baffles for the water to flow around; these baffles being fixed with an alternate space at the ends. This chamber is of concrete at 1:2:4 mix, and cost $6.00 per cubic yard.

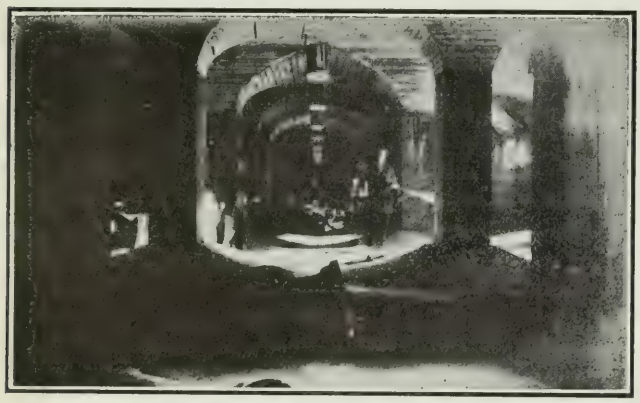
Centre Passage.—This passage is 7 ft. wide, 192 ft. long, and separates the mixing and controlling chambers from the coagulating basins, and has an upper and lower compartment. The water passes into the lower portion to the coagulation basins, and returns over a skimming weir into the upper portion of the centre passage to the filters.

Coagulating Basins.—There are two of these basins, each 120 ft. by 96 ft., with three sets of concrete baffles and two skimming weirs. These basins have a flat concrete roof supported by 126 concrete columns.

Gate House.—The location of this building is over the entire length and width of the centre passage. Here are located the controllers in connection with the valves that control the flow of water in the mixing chamber, coagulating basins and centre passage. This building is of brick construction with a cinder concrete roof covered with slate.

Filters.—The filters are twelve in number, each 28 ft. by 53 ft., situated six on either side of a pipe gallery. These filters and gutters are of concrete reinforced with ⅝ steel. The mixture is a 1:2:4, and cost $10 per cubic yard. The filters are divided into two sections with a 2-ft. 6-in. centre gutter running north and south with lateral gutters running east and west supported on the 6-inch centre gutter walls. The water flows into the centre gutter. At elevation 310.50 it passes into the lateral gutters and sprays on to the filter beds below. Each filter has a filtering capacity of three and a quarter million gallons per day. The water, after passing through the filtering medium, passes into the pipe arrangement below, through a rate controller into the clear water basins or to the clear water reservoir.

Filtering Mediums.—The filtering mediums consist of three grades of gravel and one grade of sand. The gravel is of four grades, as follows: The bottom layer is three inches thick, composed of pebbles. These pebbles pass through a screen of one inch mesh, and are retained on a screen of ⅝ inch mesh. The second layer is two inches thick; the grains pass through a screen of ⅝ inch mesh and are retained upon a screen of ⅜ inch mesh. The third layer is 1¾ inches thick, pass through a screen of ⅜ in., and are retained upon a screen of 5/16 mesh. The top layer is 1¼ inches thick, pass through a screen of 5/16 in. mesh, and are retained upon a screen having 10 meshes per lineal inch No. 20 wire. This gravel is of hard and durable rounded particles, with a high specific gravity, free from thin or flat pieces, washed and screened, and free from



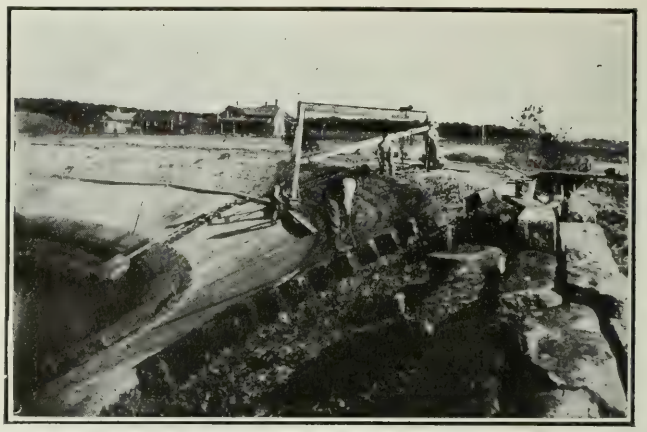
View of Groin Arches, After Removal of Forms.

sand, loam, dirt and organic impurities. This gravel, without being ground or crushed, is digested for 24 hours in cold, strong hydrochloric acid, and 95% must remain insoluble.

The filter sand is placed above the gravel, separated by a wire screen, to a depth of thirty inches, and is of a hard and durable kind, free from clay, loam, organic matter and flat particles, and stands up to a similar test as the gravel above. This sand has an effective size of not less than .35 or more than .44 of a millimeter, and a uniform coefficient of not more than 1.65. Not more than 1% is finer than .25 of a millimeter, and 90% is finer than .8 of a millimeter. The diameter of the sand grains is computed on the spheres of equal volumes, and all percentages are calculated by weight.

Clear Water Basins.—These are two in number, situated below the filters, and are 151 ft. 6 in. by 53 ft., with a concrete groin roof that supports the filters. This groin roof is supported by 26-inch concrete columns at 14-foot centres.

Pipe Gallery.—This pipe gallery is situated between the clear water basins and the filters, in which are situated the hydraulic valves, influent pipe, wash water pipe and wash water drain.



The Concrete and Stone Addition to Settling Basin to Increase Storage Capacity from 45,000,000 to 75,000,000 Gallons.

Operating Gallery.—The operating gallery is situated above the pipe gallery and extends out over part of the filters. This is of brick construction with a cinder concrete transept arch roof, covered with slate. Here are situated all the operating tables and devices for controlling the hydraulic valves, motors and all mechanical devices in connecnection with the chemicals, filters and pumps.

Pipes.—The total weight of piping in connection with the filters is 150 tons; influent, wash water and drain pipes, 365 tons; 48-inch pipe line from reservoir to Central Avenue, one and a quarter miles, 2,550 tons. Lead used, 80 tons; bolts, 6,500, assorted, for flange joints.

Clear Water Reservoir.—This is an immense covered concrete tank with a concrete groin roof supported by 960 20-in. concrete columns at 18-ft. centres. The length of the clear water reservoir is 877 ft. 6 in. by 413 ft. 6 in. by 24 ft. deep, with a capacity of storage of 47 million gallons. The total amount of concrete in this roof and columns was 15,000 cubic yards, put in at the following cost:—

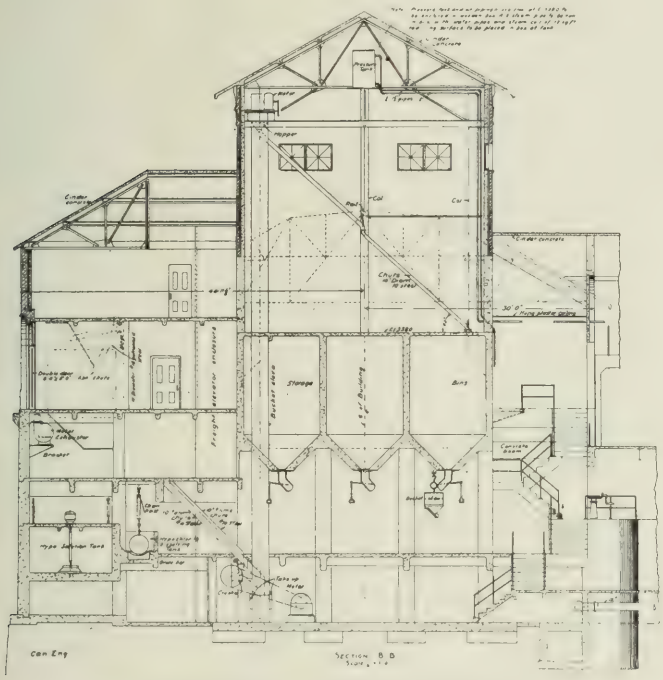
Cement	$2.00
Crushed stone	1.35
Sand	.28
Mixing, transporting, placing	.82
Form building, 2c. per sq. ft.	.10
Wrecking and placing	1.40
Total per cubic yard	$5.95

Wash Water Tower.—This wash water tower is circular in construction, 46 ft. in diameter, built of concrete from grade 296 to grade 369. Elevation 296 to 340 is used for storage rooms, and elevation 340 to 353 is for water storage. The outside facing above the grade of fill is of brickwork. This wash water tower is for the purpose of water storage with sufficient pressure for an upward wash to the filters.

Brickwork.—The brickwork facing of concrete and solid walls above the grade fill to the head house, filter building, gate house and wash water tower is laid in cement mortar. The panels are laid with dark headers and light stretchers, which give the buildings an effective appearance. All interior walls are coated with ½ inch of plaster. The cost of the labor for the brickwork was $4.00 per 1,000. All copings and window sills are of terra cotta of such a shade to blend with the brickwork.

Carpentry.—All interior doors and frames are of red oak, exterior door and frames of clear white pine; the floors to offices and rooms at grade 328 are ⅞-in. by 3-in. tongued and grooved, close grained, long leaf, yellow pine fixed to bevelled strips embedded in the concrete floor. These bevelled strips stand above the concrete 1½ inches, the intervening space being filled with cinders. A ⅞-in. by 7-in. moulded base goes around all the rooms that have lumber floors.

Laboratory and Chemical Benches.—These benches are of hard maple, made up of 1½-in. by 3-in. strips, with the thin edge up, bolted together and secured with waterproof glue. A gas machine of 150 cubic-foot capacity per hour is installed to furnish gas for laboratory purposes. The water pipe lines stand up to a pressure of 150 lbs. per sq. inch. All other pipes 50 lbs. hydrostatic pressure.



Cross Section Through Head House.

Steam Heating.—Steam heating is furniished by two boilers situated at grade 300 with a heating capacity of 1,500 square feet, capable of supplying steam for 8,000 square feet of radiation surface with a steam pressure of 25 lbs. per square inch. The radiators are of the peerless two-column type.

Vacuum Cleaner.—The vacuum cleaning system is of the rotary pump type, having a displacement of 85 cubic feet per minute when operated at a speed of 220 revolutions per minute.

Earth Fill and Embankments.—A fill is placed around the head house, filters, wash water tower and coagulation basins, from grade 301 to 323, with a 12-foot crown and a 1 in 1 slope. This embankment is to keep the water in the coagulation, filters and tower from freezing. The roof to the clear water reservoir is covered with 3 feet of earth, which will be planted and laid out in an artistic manner. The embankment to the raw water of settling reservoir has been carried up another ten feet to overcome the loss of head in the filtration plant, and to give the same pressure to the city's distribution system.

Total quantities:—35,000 cubic yards of concrete, 500,000 cubic yards of excavation, 260,000 cubic yards of fill and embankments, 900,000 pounds of reinforcement to concrete, 600,000 bricks.

Embankment and fill, watered and rolled, cost 85 cents per cubic yard. Excavations, 65 cents per cubic yard.

The accompanying illustrations show the work during construction, which was carried out under the supervision of Mr. A. W. Ellson Fawkes, C.E., chief assistant engineer on the works for the city of Minneapolis. Messrs. Hering and Fuller, consulting engineers, New York, designed the system.

PURIFICATION BY OZONE.

By R. M. Leggett.

(Continued from last issue.)

If the pre-filter removes the gross matter, the ozone will remove the bacteria and the organic matter in solution, the effluent being clear, pure and free from odor, color or taste.

Ozonization is but another name for oxidation and it is by rapid and more or less complete oxidation that the desired results are accomplished.

Ozone is allotropic oxygen expressed by the symbol O_3, as distinguished from oxygen, O_2. It is an unstable form that tends to give up its extra atom.

Bacteria are composed of about 86 per cent. water and 18 per cent. of organic matter, 6 to 8 per cent. of which is carbon. The contact of these bacteria with ozone spells their instant destruction, as the carbon is reduced by oxidation to carbonic acid, the water is freed from the organic matter and we have as a result, water, carbonic acid and nitrous and nitric oxides.

In water highly contaminated with mineral salts, these gases may very slightly increase the nitrates and carbonates, but on such a minute scale as to be hardly detectable by analysis.

It has been estimated that one million bacteria represent one-sixteenth of a milligram total weight, of which, as stated, 80 to 86 per cent. is water and the rest carbon.

The average untreated natural water contains from 1,000 to 10,000 bacteria per cubic centimeter, which represents so small an amount of carbon as to make its products of oxidation negligible.

Various devices are in use for the production of ozone, but in all, the object is to bring a current of air in contact with the silent discharge of a high-tension current of electricity.

The ozonizers in use in the Ann Arbor plant are of the tubular type, and consist of 109 tubes. They are 35 inches long and 24 inches in diameter. There are three of these ozonizers, two of which are in operation all of the time, and one is kept ready in case of emergency. The ozonizers are simply steel shells, containing 2-inch aluminum tubes, about 30 inches long, rolled in, and have the appearance of small fire tube boilers. Inside these tubes are mica tubes for the dielectrics and inside the mica tubes are other aluminum tubes. The discharge takes place between the two aluminum

tubes and the dielectric. The space in each case is about 1/16 inch, through which the air is passed.

The ozonizers are enclosed in steel tanks which have a circular dam in the middle, which forms two compartments. One compartment is the receiving end, where air under pressure from an air compressor is taken in and passed through the ozonizer. Part of its oxygen is converted into ozone and the air then passes along, as required, to the sterilizing towers.

After the air is compressed, it is passed through a cooler, thus preventing any heating of the ozonizer due to the discharge. It must be explained that only a small percentage of the energy applied to the ozonizer is utilized in the production of ozone. The greater part is lost.

Just as ozonizers are various in their form, so are, to no less extent, the means for applying the ozonized air to the water. The problem is evidently to produce a thorough mixture and in the methods in successful use there are two fundamentally different ways of doing this. In one the water is finely subdivided and passed through the ozonized air and in the other, on the contrary, the air is subdivided and passes through the water. The Ann Arbor plant belongs to the second class.

The ozonized air is conveyed to the sterilizing towers, which are built in batteries of a size to meet the capacity demanded. These towers are built on steps, with a fall of 3½ feet between each step. The water is taken in at the top of No. 1 tower, at the bottom of which are arranged suitable spray nozzles for the introduction of the ozonized air. Each tower contains four baffle plates that compel the water to travel 57 feet in each 13 feet of tower. This prolongs the contract of the water and ozone and enhances the efficiency of the system. The water leaves the bottom of No. 1 tower and enters the top of No. 2 tower, 3½ feet lower, where the same operation is repeated, and so on to No. 3 and No. 4 tower.

The chief advantages of the ozone system over any other known system of water purification lie in economy of operation, constancy of action, and freedom from costly repairs and renewals.

Nothing is added to the water to cause it to have an unpleasant taste.

No deleterious by-products are formed and odors and tastes due to organic matter are destroyed. Filtration by any means is only a greater or less reduction in the bacteria contained in the raw water. This percentage may be as high as 99 per cent. when everything is working right, but the remaining 1 per cent. in a highly polluted water may represent a grave danger. Filtration exerts no selective action. It removes the same percentage of pathogenic organism as it does of the harmless ones.

Ozone, on the contrary, has a selective action, killing all the pathogenic germs and practically all of the others. This is due to the low power of resistance to oxidation of the pathogenic germs and is confirmed by the statistics of various places where ozonization has been introduced. Paderborn, Germany, had a typhoid rate of about 1,500 per 1,000,000 population. Filtration reduced this rate to 290, and ozonization still further reduced it to zero. This plant was built in 1897 and has been in continuous operation since that time. Similar results have also been recorded in Paris, Dinard, Chartres, Nice, Weisbaden and other European cities.

In conclusion, it may be stated that any municipality using surface water may render this water safe by ozonization properly applied as outlined above.

THE ELECTRIC PURIFICATION OF WATER.*

By D. D. Vincent.

The pollution of the sources from which our great cities draw their water, and the sickness and loss resulting from the use of impure water, has drawn the attention of scientists and engineers to the various methods proposed for the purification of such water as is available.

Your attention is invited to the electrical purification of water, as practised by the Electra Pure Water Co., of this city, with which I am associated, as this method produces an ideal table water, free from organic matter, but not devoid of the necessary mineral salts.

Water purified by this process is taken from the city mains under pressure and passed between aluminum plates which are connected to a suitable source of electrical supply. It is then filtered through crushed quartz while still under pressure. We do not know to-day all of the changes which take place in the presence of the current. We do know, however, that a small percentage of the water is decomposed and that the organic matter in the water is oxidized and coagulated by the oxygen which is released and that the hydrogen combines with minerals in solution forming flakes of solid matter which can be removed with the organic matter by filtration. Repeated tests have shown that colon bacilli will not survive in this water any longer than in distilled water.

Exact work is being undertaken to establish the best practice in using this method of purification, both as to the form of apparatus used and the most economical current density and we are convinced that the cost of purification can be reduced to such a low figure as to give this method of purification a very wide application.

*Paper read before Cleveland Engineering Society.

DISCUSSION ON FOREGOING PAPERS.

Langdon Pearse*:—

The previous speakers have given a general review of the field of water purification. Mr. Pratt has shown you what the processes of filtration are, and the cost.

Mr. Leggett's paper covers the ozone plant as erected at Ann Arbor. The ozone process, as a means of sterilization, is not yet on a commercial basis in this country, in that a plant cannot be operated continuously to give uniform results, nor is it economical. This was conclusively shown by careful independent tests, made at Jerome Park reservoir, for the city of New York several years ago. Sterilization by hypochlorite of lime is much cheaper and more dependable. Ozone treatment was considered for the city of Montreal, but Messrs. Hering and Fuller in their report distinctly state that it is not yet on a basis to mertit recommendation.

The paper by Mr. Vincent describes a process for the purification of water, based on making electrolytically aluminum hydrate. Instead of adding sulphate of aluminum the hydrate is made by passing an electric current between two plates. This simply coagulates the water, and a filter is essential both to remove the turbidity and the bacteria. There is no virtue in the electric current. It is cheaper to buy the sulphate of aluminum and apply it in the usual way. In the Louisville report, in 1896, Mr. George W. Fuller ex-

* Division Engineer, The Sanitary District of Chicago. In charge of Sewage Disposal Investigations.

amined this general process very carefully, with extended tests, and concluded that it was impracticable, and extremely uneconomical.

Sanitary engineers to-day recognize that the only tried and effective means of treating a water supply to remove bacteria and turbidity, are sedimentation followed by slow sand or rapid filtration. A coagulant may be used at times with a slow sand filter, and is always required for the rapid filter. As a finishing process, chloride of lime is available to sterilize. Alone it serves as an emergency process. It does not affect the turbidity.

The situation in Cleveland is of great interest to me, as I represented Mr. Whipple for two months, in 1903. I have followed the situation since. At that time we felt that filtration would undoubtedly be required. How soon, we could not say, as the four-mile crib had only been in operation two or three months, and the sewage had not been intercepted, as originally planned. With the data available, Mr. Whipple reported that filtration would probably be required in a few years. Even if the sewage was removed from the Cuyahoga and the water front and discharged at a point some nine miles to the east of the crib, the crib would still be exposed to occasional pollution. Sewage is still flowing into the Cuyohoga in amount some 40 per cent. of the entire discharge.

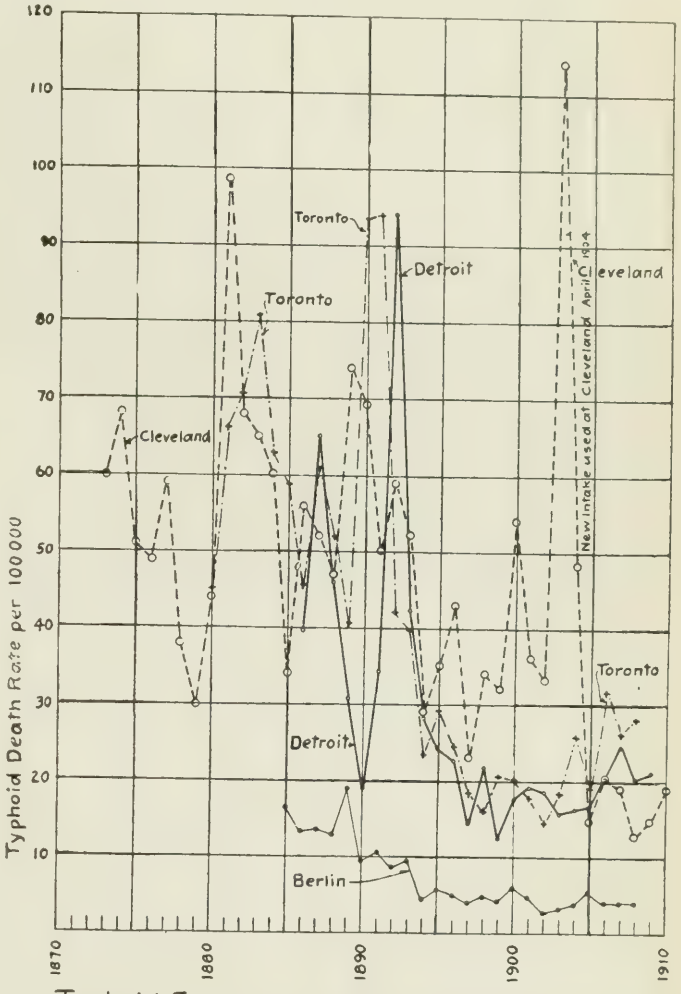
Personally, I have never understood why the four-mile crib in Cleveland was located directly in front of the Cuyahoga, even though four miles off shore. Recent tests for the Lake Michigan Water Commission have shown that under favorable conditions a sewage stream may work out even ten miles from shore before finally dispersing. The Cleveland water supply is turbid at times, and is undoubtedly open to suspicion on the ground of bacterial pollution. I have not had a chance to examine the data at hand. I do feel, however, that if there is conflicting data, all hands should get together at once and urge the appointment of a disinterested expert, a sanitary engineer of high standing, to examine into the case in the light of developments since 1903, and report whether or not filtration is not immediately advisable, particularly as the sewage has not been diverted from the Cuyahoga, and may not be for some years to come.

In the meantime, systematic data should be collected daily, particularly on the turbidity of the lake water, as taken from the tunnel at Kirtland street pumping station, its temperature, alkalinity, and bacterial content, in order to have data on hand to help in determining the filter problem. Possibly Mr. Pratt proposes to do this. It would also be very easy for him, in connection with a sewage experiment station, to build two or three small experimental water filters, and try out slow sand and mechanical filters at Kirtland street, in order to have a line on their adaptation to Cleveland conditions.

About eight months ago, in a talk at Detroit, and later before the Illinois Water Supply Association I showed a diagram on which was plotted the typhoid fever death rate of Detroit, Toronto, Cleveland and Berlin. Toronto and Cleveland both have an uneven rate. Berlin has a rate extremely low and consistently so. (See diagram.) At that time I pointed out that the Cleveland supply was open to suspicion. From what I have heard during the last two days I am convinced that immediate steps should be taken to determine whether filtration is required, at once, and to make the proper moves to finance the project, if it is required. Chloride of lime is an excellent emergency expedient to sterilize the water, and is now in use at the temporary plant.

With the modern standards of sanitation it is essential that a city have a clear water supply, always free from turbidity, and above suspicion of bacterial pollution. This is not only a valuable asset, an advertisement of progressiveness, which appeals alike to commercial men and homeseekers, as well as to residents, but is also a distinct gain to the public health, since abundant statistics point to a marked reduction in the general death rate with the accompanying reduction of the typhoid rate, when a pure water supply is introduced. The yearly saving in lives, if estimated at $5,000 each, would easily pay the interest on the cost of a filtration plant in many cases. If 40 lives can be saved yearly, this would amount to $200,000, which capitalized at 5 per cent., is $4,000,000.

The situation in Cleveland is not unique, but is a common one around the Great Lakes to-day, where a city has to



Typhoid Fever Death Rate per 100 000 at Cleveland Detroit Toronto and Berlin

discharge its sewage into the source of water supply. Chicago is the only city which can successfully divert the sewage. That is the scheme we are following to-day, as laid down by Mr. Hering in 1885. Recent investigations have shown that, with the unexpected increase in industrial wastes as well as human pollution, the rate of 3.3 cubic feet per second per 1,000 population is not sufficient. We feel, however, that the work was excellently planned, and has fulfilled its purpose. A recent report by Mr. Wisner, our chief engineer, has outlined the means open to us to increase the dilution capacity by settling the sewage in Emscher tanks. Some work must be done at once on the industrial wastes and the city sewage, since the capacity, in accordance with our legal ratio of dilution, will be exhausted in 1922. We have been operating a testing station

for over two years, and carrying along preliminary studies in the various schemes.

Milwaukee is now facing the problem. There the entire sewage of the city is flushed out into the lake, two and a half miles from the water intake. Filtration of the water has been recommended, with the removal of the sewage from the river and its diversion to a point about nine miles from the intake, where, later, settling basins, and finally, sprinkling filters will be required.

In Toronto the water supply is to be filtered, with slow sand filters, recommended, by the way, by Messrs. Hazen and Whipple, and the sewage is to be diverted to a point some three and a half miles to the east, where it is to be settled and perhaps disinfected before discharge into the lake. Dr. Amyot can tell you more of the details.

In conclusion, I may sum up by saying that it is recognized to-day that filtration of a water supply, either by slow sand or rapid filters, according to conditions, will remove impartially 95 per cent. or more of the bacteria, and the turbidity. A small amount of hypochlorite of calcium will remove practically all the remaining bacteria. The situation in Cleveland demands a most careful, unbiased investigation, at once, in order to fix whether the available data warrant the immediate expenditure of the sum required for filtration. Conditions have changed since 1903. In matters appertaining to the public health, delay is dangerous. Sterilization with chloride of lime will, however, furnish temporary protection until the decision is rendered.

VENTILATION.

By Dr. Leonard Hill and Dr. Martin Flack.*

The authors remarked that the good effects which resulted from efficient ventilation and open-air treatment, though generally supposed to be due to the chemical purity of the air, were due really to the movement, coolness, relative humidity of the air, and the ceaseless variation of these qualities. The ventilating engineer had hitherto followed a great illusion in thinking that the main object to be attained was chemical purity of air. The heating engineer had sought after an equally great illusion in striving to obtain a uniform summer temperature. The ventilating and heating engineers should aim primarily at giving air which was cool and of proper relative humidity, and which moved so as to vary the cutaneous state of the body. Comfort and discomfort in crowded rooms and shut-up places depended, not on the chemical purity of the air, but to a minor degree on the influence of the smell of the air on the olfactory sense, and, to a vast degree, on the influence of the temperature and relative humidity, and the variations of these qualities of the air, which acted on the great field of cutaneous sensibility.

The chemical purity of the air might be considered from three points of view—the concentration of carbon dioxide, the concentration of oxygen, and the supposed presence of organic poison exhaled by the breath.

Owing to the fact that a percentage of carbon dioxide exceeding a very few parts per 1,000 was not legally permissible in factories, it was commonly supposed that any greater excess acted as a poison. The truth of the matter was quite otherwise, for whatever the percentage of carbon dioxide in the atmosphere might be, that in the pulmonary air was kept constant at about 5 per cent. of an atmosphere by the action of the respiratory centre. It was impossible any excess of the gas should enter the body even in breathing the air of the worst-ventilated room, in which the percentage of carbon dioxide assuredly did not rise above 0.5 or at the outside 1 per cent.

The oxygen in the worst-ventilated theatre, school-room, or chapel was never lessened by more than 1 per cent. of an atmosphere, but all the evidence went to show that only when oxygen was lowered below a pressure of 14 to 15 per cent. of an atmosphere did signs of oxygen want arise. A diminution of 1 per cent. of an atmosphere had not the slightest effect on health or comfort.

There was no positive evidence which demonstrated the poisonous nature of the condensation water obtained from the breath, as suggested by Brown-Sequard and d'Arsonval; further, there was at present no trustworthy evidence of the existence of any such poison in exhaled air.

As to the general principles which ought to control the practice of the heating and ventilating engineer, the old English methods of open fire and open window had very much to recommend them. By the open fire air was kept moving and cool air was brought in; the heating was by radiation, and uniformity of the conditions of temperature in the room was prevented. On the other hand, the impulsion of hot air into a room was the most objectionable of all the systems employed. A cool air and radiant heat were the ideal; the hot air system gave neither. In cold weather the heated air became excessively dry; the vigor and health of children in America had been seriously undermined by the impulsion of hot "desert air" into the schools.

Uses of Ozone.—In the concluding part of their paper the authors discussed the uses of ozone in ventilation, basing their remarks on experiments carried out with an ozonizing apparatus put at their disposal by the Ozonair Company. They stated that by the smell concentrations of ozone of far less than one part in a million could be detected, and the gas should be present in the air for continuous breathing in concentrations not greater than that scarcely perceptible to the smell. Concentrations of even one part in a million were too irritative. Very weak concentrations, barely perceptible to the smell, had no ill effects, but destroyed the effect of unpleasant smells and gave a certain tang or quality to stuffy air which relieved its uniformity. It was in this respect that ozone had its use. There existed in modern conditions of life so many trade shops, tube railways, cold meat stores, etc., where the employes were exposed to a persistent, uniform, and depressing smell. The air in many buildings was made to smell by the heating appliance used. The addition of ozone took away the smell and relieved the monotony of such air, and as the Ozonair apparatus could, by the turning of a switch, be put in or out of use, the uniformity of the atmospheric conditions could thus be frequently changed. The ozone, no doubt, exerted its effect both on the cutaneous and respiratory nerves. They thought that the addition of ozonized air to the Central London Railway had improved the conditions, the unpleasant characteristic smell of the tube being diminished, and the monotonous quality of the air improved.

The Harbor Commission, Los Angeles, Cal., have decided that the harbor improvements, consisting of a 2,600-foot fireproof wharf and wharf structures are to be constructed of reinforced concrete.

* Abstract from a paper read before the Society of Arts, London, Eng., on "Influence of Ozone in Ventilation."

ECONOMIC LIMITATIONS UPON THE DEVELOPMENT OF TRANSPORTATION BY ELECTRIC RAILWAYS.*

By Guy E. Tripp.

The evolution of electric railways from the horse cars, cable cars and steam dummies of the late 80's has produced many changes in our social and industrial life. The man who formerly had to locate his home near a steam railroad line that he might go to the city each day with certainty and comfort while his family enjoyed the benefits of suburban life can now locate almost anywhere within a reasonable distance and be served safely, cheaply and expeditiously by the electric street railway. This has produced a complete change in the distribution of the suburban population of our cities and has added greatly to the value of land which was hitherto comparatively inaccessible, and the electric transportation system has become so indispensable to every large city that the loss of its service would be a public calamity which would paralyze a large part of the city's industries. Electric transportation has, in fact, become so closely interwoven in our social and economic fabric that any attempt to adjust its financial or administrative problems is far reaching in its effects and provokes vigorous opposition. It is as when one touches a spider's web; the spider is sure to rush from a dark corner to devour the disturber.

It has been generally realized for a number of years that, while some favorably located street railway properties have made a satisfactory return on the capital invested in them, many are on the border line, so to speak, while others again would show an actual deficit if their accounts were carefully analyzed and all reserves provided; yet so fearful are we of public opinion, so willing to let sleeping dogs lie, that little active and concerted effort has been made to adjust such cases and to put the properties upon a firm financial footing.

The electrical traction business was an unknown field when the horse railroads were electrified, and it has grown so rapidly during the past twenty years that its promoters and operators did not realize that in the enormous extensions of track and mileage and improvement of service they were giving the public quite another commodity than that which had been furnished by horse car lines. Settlements were made beyond the ends of lines, which soon required further extension, and the process was repeated; so, step by step our city systems have extended out into the country until, in some cases, they reach to a distance of 10 miles from the centre.

At the beginning most of the patrons of these lines lived near the city, but as the territory gradually built up the centre of density kept moving toward the outer end, constantly increasing the average haul. Further than this, the people were not satisfied with being carried to the centre of the city; they demanded that they be carried to any portion of it that they might elect; that is, that they be given transportation from any part of the system to any other part. In many cases, however, this service was traded for something else or was a wholly voluntary concession on the part of the street railway. This demand was met by the free transfer, which introduced a condition which did not exist to any considerable extent in the old horse car days and which has contributed more than almost any other single factor to the increasing cost of operating our city roads. With all these changes there has been no change in the rate of fare.

The Increase of Haul and the Transfer.—The pushing out of the centres of population and consequent increase of average haul at a fixed rate of fare and the universal transfer are the most subtle and most difficult factors to isolate and to which assign a value—much more so than mere over-extension of trackage.

It is evident that all these changes must have increased relatively the expenses of operation, but this increase has been somewhat obscured by improvements which have been made in engines, generators, motors and, in fact, in all street railway apparatus, which have tended to reduce the cost of operation and maintenance. While the operating ratio of individual companies may have shown considerable variation over a period of years, there has been no marked change in the average ratio of all companies.

This evolution in the service has also, of course, necessitated corresponding increase in the equipment, so that the investment has grown rapidly, more rapidly, in fact, than have the earnings.

The attitude of the public toward the transportation companies has changed as their service has become irrevocably established. In the beginning the agency which furnished transportation so much more rapid and for so much greater distance than had previously been possible was courted and favored. Every inducement was offered to attract anyone who was ready to electrify an existing system or to build into new territory. Small communities vied with each other in their efforts to attract extensions which would put them within easier reach of the larger sections. Almost any sort of construction and almost any sort of service was accepted gratefully and under this stimulus lines were built long before they should have been from a sound business standpoint; and the deficits that have thus accumulated must be met either by the public or by the investor who fails to receive a fair return from the beginning. The public, however, has withdrawn from the old partnership, leaving its partner to pay the debts of the concern while it retains considerable jurisdiction over the assets, upon which it proposes to base a new deal.

The efforts of the public service commissions and of the legislatures have been to secure more and more for the public, which means less and less for the transportation company. Such an attitude is but natural in light of their conception of their duty to protect the public and to advance its interest solely, while the railroad is left mainly to defend itself and its investors. It is unfortunate that many people seem to think that a public service corporation is subject to economic laws which are different from other lines of business. Now, an electric railway property is not an eleemosynary institution; it is a business enterprise. In the last analysis it is a manufacturing concern. Its product is transportation and its customers are the people who ride upon its cars. It is governed by the same economic laws as any other line of manufacture. In order that any growing business may prove a commercial success its earnings must be sufficient to pay the operating expenses and maintain the property in good condition, to meet taxes and similar charges, to replace worn-out or discarded equipment and to yield a return on its capital which is of sufficient amount and sufficiently stable to attract such additional investment as is required by the growth of the business. If all these conditions are met over a period of years, the business will prosper. If one or more of them cannot be met, the success of the whole enterprise is in danger.

*Abstract of paper delivered to American Electric Railway Association, January 26th, 1912.

The street railway business requires larger amounts of capital than it is possible to supply from its earnings, and we must turn to the investing public to secure the funds necessary; and there is nothing which attracts the public to an investment in street railway enterprises in preference to other lines of business. If the profits of the business are decreasing beyond that point, what is to be done about it?

Economies in Operation.—It is evident that the returns will be increased if we can reduce the expenses without changing the earnings or the investments, so during the last decade the efforts of every street railway manager have been directed toward securing economies in his operation. Power stations, transmission lines, car equipment, carhouses —every part of the system has been considered with a view to reducing the cost of operation and of maintenance, and the savings effected in these directions have been very satisfactory; but, as I have pointed out before, the average length of haul at the same time has been increasing steadily with a consequent increase in the cost of operation. Further than this, the cost of living has been increasing, so the final result has been that the gain by economy has been practically offset by the increase in the expenses which were beyond the control of the management. The forty-third annual report just issued by the Board of Railroad Commissioners of Massachusetts shows an average percentage of expenses to earnings in 1902 of 67.75 per cent., while that of 1911 was 65.35 per cent. I think you will agree with me that an improvement of a little les than 2½ per cent. in nine years is not, by itself, of great economic significance.

It is evident, too, that the return on the investment will be increased whenever we increase the earnings of the property without a corresponding increase in the expenses and investment. This, however, would have to come from an increase in the rate of fare, or by reducing the amount of transportation which is given for a single fare; that is, we might adopt some form of zone system or we might charge a passenger for a transfer. These sources of relief have been tried to only a very limited extent in this country.

The third factor entering into the return on the investment, and one which is not generally understood, is the ratio which the investment bears to the gross earnings of the business. Many know, in a general way, that in a street railway the investment may profitably be four or five times the gross earnings, but it appears not to be so generally understood that this ratio varies with the operating ratio of the business, and will increase or decrease as the operating ratio goes up or down, moving always in the opposite direction.

I believe there has been a decided increase in the ratio of investment to gross earnings (and please note that I say investment and not par value of capitalization) in our street railway enterprises. I base this idea largely upon the returns which are made to the Massachusetts Railroad commissioners, for these returns are unusually complete: they cover companies doing a railway business only and the capitalization is carefully supervised by the Railroal Commissioners and is based on the investment in the property.

Ratio of Investment and Earnings in Massachusetts.—I find that in 1891 the net investment in the traction system of the State was approximately $27,500,000, while the gross earnings for that year were $8,900,000, so that the investment was 3.1 times the annual gross earnings. Ten years later, in 1901, the investment was approximately $99,500,000 and the earnings $23,000,000, so the investment was 4.3 times the gross. In 1911 the investment was $172,100,000, and the gross earnings approximately $37,000,000, a ratio of 4.65 to 1. This increase in the investment ratio without a marked reduction in the ratio of operating expenses has, of course, produced a reduction in the amount available for interest, depreciation and similar charges and, since the property must be maintained, it must mean that the return on the investment has been reduced.

For example, a company earning $100,000 in 1891 represented an investment of 3.1 times the gross, or $310,000. If we assume the operating expenses at that time were 70 per cent., $30,000 was left to take care of taxes, interest, depreciation, etc., this being 9.65 per cent. on the investment. In 1911, however, a company earning $100,000 gross would have an investment of $465,000 and, if operated for 65 per cent., there would be $35,000 to apply against the above charges, which is at the rate of 7.55 per cent. of the investment.

The profit may be improved by proceeding along one or all of three general lines. We may reduce the ratio of the investment to the earnings, or reduce the operating expenses, or increase the earnings, and if we can do the last without an increase in the investment, we will have accomplished the first automatically; that is, the ratio of investment to earnings will be reduced. You will agree with me that we cannot reduce the investment which we have already made and I am slow to believe that our effort to reduce expenses will be more successful in the future than in the past. Trackless trolleys, pay-as-you-enter cars, campaigns against accidents have promised good results, but the effect of their adoption has not been marked. I believe that our city lines cannot secure additional business at a rate of investment less than the present average. It would seem, therefore, that the only solution of this vexing situation, and the one which will put the street railway business upon a firm and equitable basis, is a readjustment of our system of fares. Just what this readjustment should be I am not prepared to say, but I believe that the situation should be well understood, and an educational campaign should be carried on. The problems which confront us are not new. The horse railroads had the same difficulty and their fares were made 6 cents or 7 cents or 8 cents or 9 cents, as circumstances justified, and the people paid these fares, not without grumbling, it is true, but nevertheless they paid.

Effect on Electric Railway Development.—I have seen it stated that there has been a decided letting up in the development of electric railway enterprises during the last ten years, and tables showing the total mileage of electric lines in this country have been quoted to show that this is the case. Statistics of this sort are extremely difficult to obtain and still more difficult to check with accuracy, but I am inclined to believe that the figures quoted do not fairly represent the conditions; for instance, this table shows an increase of only 1,200 miles in the total trackage from 1907 to the end of 1910, yet the statistics published each year in the Electric Railway Journal show that during this same period almost 3,400 miles of new track were constructed. To bring this up to date we must add approximately 1,000 miles constructed during the year 1911, so it would appear that during the last four years over 10 per cent. has been added to the total existing track.

I have tried to analyze these figures somewhat; and, while the results are probably somewhat inaccurate, I think they show fairly well the conditions which exist. In 1907 the interurban mileage was rouhhly one-fifth of that in the cities, and during the four years I have mentioned the addition to the city track was 2,048 miles, or approximately 7 per cent., while the addition to the interurban was 2,419 miles, or approximately 43 per cent. As I said before, these

figures may not be strictly accurate, yet I believe they show fairly the conditions which exist.

One of the essential differences between the ordinary interurban and the city lines is that the former bases its fare upon the number of miles the passenger is carried, and is thus able to proportion its charge to the service it gives, while the city line operates upon a fixed fare and hence is often forced to take business upon a losing basis. Furthermore, our city governments and our railroad commissions have as yet failed to give the interurbans the same strict supervision that they have to the city properties, and this has tended to make the interurbans more attractive. I believe we are justified in saying that we have probably reached the limit of economic development of our city lines on the present fixed rate of fare, and not only that but further, if existing taxes, prices and service are not to be reduced, there must be a readjustment of the fixed 5-cent fare and universal transfer in order to insure a fair return even on the present investment.

SOME REFRACTORY SUBSTITUTES FOR WOOD.

At the meeting of the American Society of Mechanical Engineers held in Boston, November 16, 1911, the Boston Society of Civil Engineers and the Boston section of the American Institute of Electrical Engineers coöperating, a paper was presented by Prof. Charles L. Norton, Mem. Am. Soc. M.E., of the Massachusetts Institute of Technology, on Some Refractory Substitutes for Wood. An abstract of the paper follows:

The common use of wood in and around our buildings is responsible for a considerable part of the annual fire loss, and the discovery or invention of a satisfactory substitute which would possess the desirable properties of wood and yet be non-combustible has been long hoped for. It is clear that in order to be accepted as a substitute for wood in building construction, a new material must approximate in lightness, strength, elasticity and ease of working, the natural woods, and further, since the variation in natural woods fits them for special details of construction, the substitute must be had in different grades of hardness, toughness, fineness of texture, etc. Moreover, the ease of working, sawing, boring, nailing and so on, leads to a wide use of natural wood, and a substitute to be acceptable must approximate the ordinary natural woods in these respects.

Many of the earlier attempts were made in the direction of altering the natural wood by some chemical treatment, so as to make it ignite with greater difficulty and burn more slowly and without much flame. These processes afforded a number of so-called fireproof woods. The principle underlying the chemical treatment was usually one of two. First, the wood was saturated with a solution which, on drying, left in the pores a salt capable of giving off a gas when heated, this gas being of such a nature as to be incapable of supporting combustion. Phosphate of ammonia and tungstate of soda were extensively used for this purpose. With thorough saturation the protection afforded the wood and adjoining portions of the structure was by no means insignificant; specimens of wood treated with phosphate of soda have been in the possession of the author for more than ten years, and after ten yearly tests show no signs of deterioration. Similarly some specimens of wood and cloth treated with tungstate of soda in 1903 have shown little or no loss in fire resistance. The main value of such chemical protection lies in its diminishing the volume of the resulting flames. When once thoroughly ignited, the fireproof wood burns more briskly than the natural untreated wood.

The second method of chemical treatment was one in which such substances as alum were used in order to supply a considerable quantity of steam from the water of crystallization and also to encase the pores of cells with a solid refractory substance.

A still earlier procedure was that of protecting wood from contact with a combustion-supporting atmosphere by coating it with thin sheet metal, usually tinned iron or copper. For doors and shutters this was found very effective. More recently hollow metallic members for doors and trim and for furniture have been extensively used, with a considerable degree of success. They are, of course, non-combustible, and under ordinary exposure keep their shape fairly well.

The wooden lath is without doubt responsible for the rapid spread of fire in many buildings of the older types of construction, and the attempts to develop a substitute have resulted in the metal lath and in the so-called plaster boards. The former are eminently satisfactory as substitutes for wooden lath, their greatest defect being their liability to become weakened by corrosion in damp places when used with certain kinds of plaster. The plaster boards are made of plaster of paris and some fibrous binding material, often wool, hair, or jute. Some are made of superposed layers of wool, felt and plaster. All, however, contain so large a percentage of plaster or other non-combustible material that combustion proceeds very slowly.

There have been from time to time, in the last 30 years, attempts to make use of boards composed only of refractory, inorganic substances. In general, such boards have been composed of some fibre and a cementing medium. The most popular fibres for this sort of experimentation have been asbestos and mineral wool, the cements used including about all the common cements of both the air drying and the hydraulic types. Oxychloride of magnesium, the value of which as a cement was discovered some 50 years ago by Sorel, has been the favorite cement for experimenters because of its simple preparation, its quick hardening and great strength. For some reason, however, a large percentage of the oxychloride cement is variable in its properties and often defective. When mixed with sand or similar dense bodies the oxychloride is often satisfactory for long periods, but the experience of the author with mixtures of this cement with fibres, both organic and inorganic, leads to the conclusion that it is unstable and unsatisfactory. This is more probably the case when the boards are used in damp places or out of doors.

There next appeared a number of wood substitutes in which a fibre was bonded by silicate of soda, commonly known as water-glass. Some were made in this country, but the most serious attempts were made in England and Russia, where the Imshenetzky process was used to make a board called uralite. It was the most satisfactory substitute for wood which had appeared up to that time. Uralite was composed of a sheet of asbestos millboard saturated with a solution of silicate of soda, which was subsequently precipitated as colloidal silica by a solution of bicarbonate of soda. For some reason not connected with the physical or chemical properties of the material, uralite has practically disappeared from the market. There have appeared from time to time a number of patents for boards composed mainly of fibres and lime, but no great use seems to have been made of them.

After much study two conclusions seemed inevitable to the author: First, no homogeneous inorganic substance was likely to prove satisfactory, but that a mixture of a fibre

and a cementing substance was necessary to give wood characteristics to the material; and secondly, a mixture of asbestos fibre with one or two cements (first oxide of magnesium or calcined magnesia, and second calcium silicate and aluminate mixture) seemed more suitable than any other combination.

The author proceeds to describe what he calls asbestos wood made under his patents and developed from the application to mixtures of certain processes of mixing, pressing and curing. It is stated to be practically incombustible, harder than natural woods, to have a transverse strength about two-thirds that of white pine with the grain, and, without being brittle, an elasticity less than that of natural woods; the coefficient of thermal conductivity has been found in English units to be between 50 and 30 B.t.u. per sq. ft. per 24 hours, per 1 deg. Fahr.

The weight of the several grades of asbestos wood 1 in. thick varies from 8 lb. to 13 lb. per sq. ft. White pine 1 in. thick when dry weighs approximately 3 lb. per sq. ft., and oak about twice as much. The transverse strength of boards and the maximum fibre stress is between the limits of 5,000 lb. and 10,000 lb. Test specimens 12 in. wide, 12 in. long and ¼ in. thick, broken by centre load when supported on two edges with 11 in. span, broke on an average at 200 lb. load. Under the same conditions clear white pine broke under a load of 300 lb. with grain and 20 lb. across it. In some cases the equality of strength in both directions is of great advantage.

The tendency of the material to absorb water varies between the limits of 4 per cent. and 20 per cent. This absorption is not of such a nature or amount as to cause disintegration from freezing and the material is not injured by prolonged soaking in fresh water. Sea water tends to disintegrate it after a time, the magnesium salts in the water replacing the calcium of the cement.

The coefficient of expansion varies with the temperature and also with the age of the specimen. It is small, being about 0.000004 at ordinary temperatures, diminishing rapidly at 700 deg. Fahr. and becoming negative at 950 deg. Fahr. where shrinkage occurs.

The operations of boring, sawing and finishing are all somewhat more difficult with asbestos wood than with the natural woods. It withstands scraping and rubbing much better. Floors and stair treads made of the material wear well, but are liable to be slippery when wet.

Many of the common wooden details of modern buildings have been successfully duplicated in asbestos wood, doors usually being hollow to save weight. Wherever there is danger of ignition of wooden framework a lining of the material has been found effective, notably in the vicinity of electric apparatus. It has been found best to mold the sheets while still in a plastic condition so as to form large pipes or ducts, and many locomotive round-houses have been equipped with smoke jackets or ventilating hoods. Shingles which have been in the weather for years have proved durable and this quality seems certain to equal that of fire resistance.

The ability to stand heat makes it available for blocks on friction brakes where a flexible material is not needed. The coefficient of friction of iron is approximately 0.3 to 0.4.

It has also been used as a mold for glass utensils during the process of manufacture, its non-conducting properties making it preferable to iron in some instances.

It is, of course, the fire resistance of the asbestos wood which gives it its greatest interest. There is nothing combustible in it, and on exposure to fire nothing can occur except a gradual dehydration of both fibre and cement. Under prolonged red heat the boards become weakened, but for such exposures as occurs in fires in buildings the resistance is ample. For instance, a sheet of ¼-in. asbestos wood may be placed over the top of an open furnace at 1700 deg. Fahr., the flame impinging directly on the lower surface of the sheet, and at the end of half an hour the sheet may be taken off and while its lower side is still white hot be plunged into cold water and then returned to the furnace for 10 minutes. It may be slightly warped and its strength will probably be diminished 25 per cent. or more, but it will still be sound and whole and free from cracks or serious weakness. Fire tests have shown the ability of the material to withstand much longer exposure, but it is not suitable for linings for furnaces or kilns which are kept constantly at red heat. In some fire tests the paint on the outside of an asbestos wood door 1¼ in. thick was not scorched after the fire inside had been burning at a temperature of 1700 deg. Fahr. for more than an hour.

BRITISH COLUMBIA'S MINERAL PRODUCTION.

An estimate of British Columbia's mineral production has been prepared by Mr. W. F. Robertson, provincial mineralogist, which is really a prelminary review of the progress made in 1911, with an approximate estimate of the quantities and value of the province's several mineral products.

The estimated mineral production is $23,211,816. If the revised statement which is made up after the receipt of all mining returns shows this amount to be approximately correct, it will then be seen the amount was smaller than that of 1910 by $3,165,250, and less by various amounts than that of any year since 1905.

The curtailment of ouput is attributable for the most part, if not entirely, to the effects of the strike of coal mine employees in the Crow's Nest district of South-east Kootenay. The suspension of work at the mines and coke-ovens lasted for practically two-thirds of the year, and prevented the production of coal and coke during that period to an extent that involved a decrease in value from East Kootenay alone of nearly $3,000,000. If to this be added the decrease in value of the production of metals of one copper producing company alone—as compared with 1910, of $1,600,000—which was the direct result of the cutting off of the supply of coke for its blast furnaces, there will be obtained a total decrease of more than $4,500,000, which was an immediate consequence of the labor difficulties at the Crow's Nest collieries.

There were other temporary obstacles to production being maintained at the ordinary rate which also in a lesser degree accounted for a decrease in the output, these either have been overcome or are likely soon to be removed. Meanwhile a settlement has been made of matters that were in dispute between the coal-mine operators and their employees, thus by the end of the year the normal output of coal and coke was being gradually restored.

British Columbia's proportion of the mineral production of Canada is comparatively large. The whole value of the production of this province to the end of 1911 is approximately $397,000,000, since the published official records of the whole Dominion do not include production prior to 1886, the present comparison must be confined to the period of twenty-six years—1886-1911. Placing the aggregate for the whole of Canada at $1,245,000,000 (which allows for 1911 a Dominion total of $115,000,000, an amount $10,000,000 greater than that of 1910), and British Columbia's proportion for the same period at $333,000,000, it follows that this Province has to be credited with nearly 27 per cent. of the value of the mineral production of the whole of Canada in the twenty-six year period under notice.

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HYDRAULIC TURBINE DESIGN.

The recent failures of water-wheel casings, as a result of which great damage was done to the power houses and electrical equipment, bring to mind the fact that water-wheel design is as yet in an elementary condition as regards the handling of certain features by the hydraulic engineer. The failures in question and the attendant results were caused by the breaking of the wheel casings. There is little excuse for failures of this nature with the present state of hydraulic theory and structural design.

A few years ago failures of this nature rarely occurred. Now, however, they are becoming increasingly frequent in number. The reason for this increase is hard to see, for the theory of turbine design has advanced very rapidly, until now we have reached a state of near perfection with regard to efficiencies, etc. Likewise, our knowledge of the strength of materials and the stresses induced has developed. Too little account, however, is paid by the manufacturer of hydraulic turbines and the hydraulic engineer to the new conditions which have arisen in connection with water-power development. Many plants are being installed having long penstocks, and these inevitably cause trouble unless handled properly. The difficulties of regulation caused by long feeder penstocks are hard to deal with, and as a result the manufacturer and the engineer have left the question to solve itself. Many plants are now struggling along with practically no regulation on account of the above. Difficulties other than regulation are liable to develop as in the above noted failures. The vibrations and oscillations set up in the penstocks as a result of change of load, or load thrown off, induce excessive pressures in the penstocks and wheel casings. When no account of such excessive pressures is taken, or means furnished to relieve the condition by the installation of relief valves, bursting plates or standpipes, trouble will certainly develop.

In a design which came to the writer's attention recently a small bursting plate was placed at the lower end of a penstock 1,500 feet long, and this was the only provision made for safeguarding the penstock and wheel casing. The specifications for the water-wheel governors did not state the minimum time allowed for full closure of the gates. On investigation it was found that the governors would have to be set for minimum time closure of eight seconds to ensure safety to the penstock. With conditions such as these, is it any wonder that the failures of wheel casings are increasing?

In order to prevent serious criticism, hydraulic engineers must pay more attention to this feature of power plant design. It is often cheaper and easier to neglect the regulation side of the design, but it will be usually found that such neglect is very costly in the end to the power plant owner as well as to the reputation of the engineer.

WATERPROOFING OF CONCRETE.

The waterproofing of concrete has become very important on account of its widespread use in building and engineering construction. For some time the opinion of engineers who have paid some attention to this phase of Portland cement and concrete has been that little benefit is gained by using the waterproofing mediums now sold on the market. It has been stated by the manufacturers that the use of these so-called integral waterproofing compounds would procure an impermeable con-

crete or mortar, and a few years ago results seemed to justify their use. However, many intelligent and comprehensive tests on the absorbtive and permeable qualities of Portland cement and concrete have been made, and these experiments almost universally show the same results.

Tests on the waterproofness of concrete are difficult to execute, for the constituents vary in absorptive qualities, porosity and percentage of voids. The Bureau of Standards of the United States has just finished a series of tests of the absorptive and permeable properties of Portland cement mortars and concrete, together with tests of damp-proofing and waterproofing compounds and materials. An endeavor was made to conduct these tests in such a manner as to make the results of practical value as a determination of the comparative values of these mediums. Forty different compounds were purchased in the open market and several void-filling materials were obtained for testing. A complete record of each compound is reported as to its character, chemical analysis, method of application, the result of physical tests, and noted peculiar characteristics.

The compounds are of two general classes, the waterproofing compounds for preventing the flow of water through masonry where subjected to a hydrostatic head, as in reservoirs, cisterns, tunnels, cellars, and the like; and damp-proofing compounds for overcoming dampness resulting from the capillary attraction and absorptive qualities of masonry, preventing dampness in habitations, and the disfigurement of exterior and interior surfaces of brick, stone, and concrete walls and interior plastering and decorations due to staining and efflorescence.

Two series of tests were made in the investigation, one of the waterproofing or water-resisting qualities of the compounds recommended for such use, and another of the damp-proofing qualities of other compounds so recommended to be used.

A summary of the results of the tests shows that Portland cement mortar and concrete can be made practically water-tight or impermeable to any hydrostatic head up to 40 feet without the use of any of the so-called "integral" waterproofing materials; but in order to obtain such impermeable mortar or concrete considerable care should be exercised in selecting good materials as aggregate and proportioning them in such a manner as to obtain a dense mixture. The consistency of the mixture should be wet enough so that it can be puddled, the particles flowing into position without tamping. The mixture should be well spaded against the forms when placed, so as to avoid the formation of pockets on the surface.

The addition of so-called "integral" waterproofing compounds will not compensate for lean mixtures, nor for poor materials, nor for poor workmanship in the fabrication of the concrete. Since in practice the inert integral compounds (acting simply as void-filling material) are added in such small quantities, they have very little or no effect on the permeability of the concrete. If the same care be taken in making the concrete impermeable without the addition of waterproofing materials as is ordinarily taken when waterproofing materials are added, an impermeable concrete can be obtained.

The damp-proofing tests as conducted would indicate that Portland cement mortars can be made not only impermeable, but damp-proof as well without the use of any damp-proofing or waterproofing compound. However, these tests should be interpreted with caution, as the evaporation may have been sufficient to care for the slight amount of moisture coming through the test pieces without indicating on the filter paper. Thus it cannot be stated that if a material were used which was damp-proof according to this test, if used as a basement wall, one surface being constantly exposed to moisture and the other surface in an enclosed room where there would be little or no circulation of air, that the interior surface would not appear damp and the atmosphere become saturated with moisture. The tests of coating materials as damp-proofing mediums can be considered as only preliminary, but the results, considered along with the chemical discussion, throw some light on their comparative merits. The mortar used in these tests was, perhaps, too coarse and too absorptive for a fair test. The purpose of the rough surface was to test the flowing qualities of the coating, and it would seem that many of the failures may be due to the poor or imperfect spreading and adhesive quality. Several of the compounds deteriorated and proved their unfitness for the purpose intended.

Well-graded sands containing considerable graded fine material are preferable for making impermeable concrete, but if such is not to be had, fine material in the form of hydrated lime, finely ground clay, or an additional quantity of cement will be found of value.

Where Portland cement mortar is used as a plaster coat, if sufficient cement be used and the sand contains sufficient fine material (or a fine material be added) and the mortar be placed without joints and well troweled (care being taken not to over-trowel, which may cause crazing), the coating will be effective as an impermeable medium without the use of any waterproofing compound.

As a precaution, under certain conditions, it is undoubtedly desirable to use bituminous or similar coatings, even on new work, as protection where cracks may occur due to settling of foundation or expansion and contraction caused by temperature changes. In large or exposed work it is practically impossible to prevent some cracks, but where cracks can be prevented no coating whatever is required to make the structure impermeable.

The permeability of Portland cement mortars and concretes rapidly decreases with age.

EDITORIAL COMMENT.

The Commission of Conservation have begun the publication of a monthly paper called "Conservation." The March issue, which has just come to hand, states that it will be published during eight months of the year. This bulletin will be invaluable to the press, containing as it does authoritative information on conservation matters.

* * * *

Commercial peat seems to be very nearly a realization now. The method of treatment heretofore has not been economically successful. That difficulty, however, has been overcome, and a thoroughly successful method of treating peat has been practically demonstrated at the Government laboratories near Ottawa during the last two years. All that remains now to make the immense peat bogs of the Province of Ontario available for fuel is a reasonable amount of commercial enterprise devoted to the work of development.

* * * *

Toronto has decided to build a sewage purification experimental station. The results to be obtained from the operations of such a station are very valuable, and

no doubt the local sewage disposal problem will be greatly cleared by the proposed experiment. The sewage disposal problem of the cities bordering on the Great Lakes has come to be a serious one, and it is only by experimental work that the degree of clarification necessary for preserving the water supply will be discovered. It is sincerely hoped that the experimental work will be prosecuted energetically in order that the resulting data may be of immediate service before the building of sewage treatment works.

GENERAL NOTES.

Precipitation during March exceeded the average very locally in Ontario, and in Eastern Quebec, Northern New Brunswick, and Eastern Districts of Nova Scotia. Elsewhere in Canada it was deficient, and in British Columbia and the Western Provinces, to a marked extent. Practically no reports regarding the amount of snow on the ground in British Columbia have been received, but it is apparent that there is a considerable amount on the mountains, although it is probably less than at the end of February. In the Western Provinces there is comparatively little snow on the ground, the depth in Eastern Saskatchewan and Manitoba being from two to four inches, while in other districts the ground is practically bare. A large amount of snow, between thirty and forty inches, lies on the ground in Northern Ontario and over the greater part of Quebec, but this depth decreases southward to a trace near the shores of Lake Ontario and near the Bay of Fundy.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for March, 1912:

	Depth in inches.	Departure from the average of twenty years.
Calgary, Alta.	0.3	— 0.44
Edmonton, Alta.	0.4	— 0.37
Swift Current, Sask.	0.1	— 0.76
Winnipeg, Man.	0.3	— 0.95
Port Stanley, Ont.	2.6	— 0.26
Toronto, Ont.	1.97	— 0.23
Parry Sound, Ont.	1.7	— 1.31
Ottawa, Ont.	1.5	— 1.03
Kingston, Ont.	1.6	— 0.70
Montreal, Que.	2.0	— 1.90
Quebec, Que.	2.2	+ 0.61
Chatham, N.B.,	3.7	+ 0.57
Halifax, N.S.	6.7	+ 1.36
Victoria, B.C.	1.4	— 1.40
Kamloops, B.C.	0.0	— 0.42

FREE ASSISTANCE IN DRAINAGE.

During the exceptionally dry season of 1911 land that was underdrained produced on an average about $16.50 more per acre than land that was not drained, according to data collected by the Department of Physics at the Ontario Agricultural College.

Reports were received from a large number of farmers, of whom twenty-five were able to give definite figures on yields on drained and undrained land. Three of the number said they saw no difference, but all the others reported increases. Eleven counties were represented in the reports, from Durham in the east to Essex in the west. The value of increases, including straw, was figured at October, 1911, prices, and March, 1912, prices. The former showed an average of $15.97 per acre and the latter $17.04, and both together an average of $16.50. The three who reported no increase were counted in obtaining the averages.

In wet seasons the results are even more marked, but even at $16.50 per acre, drains more than pay for themselves in two years.

The O.A.C. is again renewing its offer of assistance to farmers in laying out their drainage systems. The Department of Physics has a special staff of drainage advisers for this work. There is no charge for the services of these men, the only outlay to the farmer being the travelling expenses, which are low. As the railway fare is only one cent a mile for this work, and as several surveys are always made on one trip the expenses are divided among the several parties concerned. Anyone wishing to have a drainage survey made should drop a card to the Department of Physics, O.A.C., Guelph, whereupon regular application form will be sent, and later on one of the department's drainage advisers will make the survey.

PROFESSIONAL DEGREES IN ENGINEERING.

In the year 1895 the University of Toronto passed a statute establishing professional degrees in civil, mining, mechanical and electrical engineering.

Candidates for any of the said degrees were required, in addition to three years' professional experience, to hold the diploma of the School of Practical Science, and also the degree of B.A.Sc. The latter requirement being imposed upon those only who graduated from the school subsequent to June, 1895. Since the passing of the above act a large number of men have graduated who, through their professional activities, have found it impossible to meet the latter requirement of the statute. Some of those of this number have turned their attention to other activities, and many have already made good in their profession, and it has been felt that at least a measure of relief should be given to the situation. The University, therefore, recently amended the statute by changing the date up to which the B.A.Sc. degree would not be required from June, 1895, to June, 1905. By this amendment statuary difficulties at least in the way of proceeding to a professional degree have been removed from about 190 graduates.

OIL-BURNING LOCOMOTIVES.

The Canadian Pacific Railway has decided to use oil in its locomotives on Vancouver Island. The reason for this is because of the stringency of the forestry regulations, which makes a railway responsible for fires originating on its right-of-way. Recently in the supreme court at Nelson, the finding of the jury was that the Canadian Pacific Railway was responsible for the damage done to timber limits of the King Lumber Company, and awarded $140,000, the amount sued for. In that case, the fire started on the right-of-way, smouldered for some days, then was swept by a wind across the Moyie River and later carried by another wind into the timber. It is fairly convenient to burn oil on the coast lines, since transportation from the oil fields is by water, but the question of using oil in the interior has not yet been taken up for definite settlement. With many waterpowers available throughout the whole of the interior, electrical power will probably be utilized when a change is made from the use of coal in locomotives.

SURFACE TREATMENT OF PARK ROADS.*

By Col. Spencer Cosby, U.S.A.

The greatest friend of the American road builder of today, the much maligned and loudly abused automobile, has undoubtedly been the chief single factor in the wonderful advance that has taken place during the last decade, both in the art and in the extent of our road making. Through the instrumentality of the motor car many thousands of our most influential citizens have had carried home to them the conviction that the necessity for good roads is not merely a local issue but is a question of nation-wide importance, and never before in our history has the interest in it been so great nor have such large sums been spent in the making and upkeep of our roads.

But while other factors than the automobile have contributed an important share towards achieving this result in the general case of country and suburban roads, the improvement that has taken place in our park roads during the last few years can be attributed almost solely to the automobile. Until its advent the traffic on these roads was in most cases confined exclusively to light vehicles, so that ordinary macadam, or even well compacted gravel roadbeds, met all requirements.

Here in Washington our roads were thoroughly gone over and all defects repaired once each spring, and this, with frequent watering, sufficed to keep them in good condition for many years—in fact, they never seemed to wear out. The yearly repairs cost comparatively little, the chief item of expense of maintenance being the watering. This averaged about 3.2 cents per sq. yd. of road surface per annum. No watering was done during the three winter months, while in the early spring and late fall the roads were watered once a day in dry weather; during the remaining six months of the year the watering carts went over each road twice a day during dry weather, and three times a day in periods of drought. As long as the roads were kept fairly smooth and reasonably free from dust, everyone was satisfied. No attempt was made to clean the roads, though the gutters were swept from time to time.

But this happy state of affairs ended with the coming of the automobile. The number and average weight and speed of the vehicles using the parks rapidly incrased, the combination of horses' hoofs and driving wheels with wide soft tires quickly raveled the road surfaces, and at the same time their users became more particular—they wanted not only dustless but mudless roads and could not see why a hole which developed in the fall had to wait for the annual spring cleaning to be repaired. They even complained when a road became occasionally dusty during the winter months. In other words, they wanted the park roads to be good at all seasons and in all weathers, and that is what we are now trying to give them.

On the new roads that have been built and on the old roads that have been resurfaced in the last few years a heavy oil or tar binder has been used with most satisfactory results, the penetration method being employed in applying the binder. But most of our work has consisted of the surface treatment of existing macadam roads. We have never attempted to apply any treatment to the old gravel roads but are resurfacing all of these as fast as possible with broken stone. For our surface treatment we have experimented with emulsions, with waste sulphate liquor, with coal gas and water gas tars and with asphaltic oils, and have come to the conclusion that, under present conditions, the latter give the best results.

Our experience with emulsions has not been very extensive. We found that the effect of each application lasted only two or three weeks, the time depending largely on the amount of rain, and we soon reached the conclusion that the cost of labor and material for the repeated applications that were necessary made the cost of this method greater in the end than that of the others. It has the advantage that the road never has to be closed to travel even while the material is being applied, though there is some objectionable tracking for about a day afterwards.

We have also used sulphite liquor, but to only a limited extent, owing to the fact that the first cost of the material is much greater than that of either oil or tar, while its effect is not so lasting. It possesses the advantages of allowing the road to be used immediately after application, of not permanently darkening the color of the road surface and of not staining.

In this market water gas and coal gas tar cost about the same, but the former has given better results in use on roads, as the coal gas tar does not retain its elasticity and so does not have as good binding power. We have used the same method in applying water gas tar and light asphaltic oil, and have found the effect to be about as lasting in each case, one application a year being sufficient to keep the road in good condition. The oil has, however been slightly cheaper than the tar in this market, and it requires a smaller quantity to be used per square yard on the second application; it is also more absorbent of the triturated material that forms on the surface of the road under traffic, and so makes a more nearly dustless road. For these reasons we now prefer it ta tar, though I confess to some misgivings as to the ultimate effect of the crust formed upon the road surface by the commingled oil and dust. Even now, where the traffic is heavy the crust is picked up in places, forming occasional ruts and waves.

Our method of applying oil to macadam roads is as follows:—

All ruts and holes in the surface of the road are first repaired by cleaning out the cavity, filling it with coarse stone, which is covered with a coating of hot, heavy, asphaltic oil, then sprinkling a light coat of screenings over the oil, and finally compacting the mass by ramming. When all holes have been repaired, the surface of the road is thoroughly cleaned with rattan brooms, care being taken to remove all loose materials and caked dirt or dust so that the stone forming the wearing surface of the road shall be exposed and clean.

When the road is entirely free from moisture, and during warm, dry weather if possible, a light asphaltic oil is spread, without being heated, over its surface by means of special sprinkling wagons. One-third to one-half gallon of oil to the square yard usuall yforms this first application. To allow it to penetrate into the surface, the road is closed to traffic for at least forty-eight hours after the first application. At the end of this time the surface of the road is covered with a thin coating of clean, coarse, sharp sand or broken stone screenings, free from dust; it is then rolled and traffic allowed to go over it. A cubic yard of sand or screenings usually covers from 75 to 125 sq. yds. of road surface.

In this climate and under the conditions of traffic obtaining on our park roads, the oiling treatment described above keeps the surface in excellent condition for a year. It is never dusty and is only muddy when, for a few hours after a heavy thaw, the skid chains of automobiles tear up the surface. The subsequent passage of automobiles with-

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out chains soon irons out the roadway. At the end of the year the surface of the road is again thoroughly cleaned, from ¼ to ⅓ gal. of oil per sq. yd., under normal conditions, is spread over it and the road closed for forty-eight hours and covered with sand or screenings as before. This treatment is continued from year to year.

Instead of handling the oil in barrels, we have found it much cheaper to buy it delivered in tank cars, from which it is unloaded into the sprinkling wagons. A pressure tank wagon was used to advantage for the first application of oil to the road surface, but ordinary sprinkler wagons with an oil distributing attachment and a squeegee fixed behind the distributor were found more economical and equally efficient in spreading the oil the second year. To insure coating all parts of the road with an oil layer of uniform thickness, men with stiff brooms followed the sprinkler.

The following are the specifications under which we have been purchasing asphaltic oil for the surface treatment of park roads:—

(1) The oil shall be a viscous fluid product, free from water and showing some degree of adhesiveness when rubbed between the fingers.

(2) It shall have a specific gravity of not less than 0.940 at 25° C.

(3) It shall be soluble in carbon bisulphide, at air temperature, to at least 99 per cent. and shall show not over 0.2 per cent. of inorganic matter insoluble.

(4) It shall contain not less than 3 per cent., nor more than 10 per cent., of bitumen insoluble in 86° paraffin naphtha at air temperature.

(5) When 240 c.c. of the oil is heated in an Engler viscosimeterto 50° C. and maintained at this temperature for at least 3 minutes, the first 50 c.c. shall flow through the aperture in not less than 10 minutes, nor more than 20 minutes.

(6) When 20 grams of the material is heated for 5 hours in a cylindrical tin dish aproximately 2½ ins. in diameter by 1 in. high, at a constant temperature of 163° C., the loss in weight by volatilization shall not exceed 20 per cent. The residue should be decidedly sticky.

(7) Its fixed carbon shall be not less than 3.5 per cent.

The following table, taken from the year's report of the Office of Public Buildings and Grounds, shows the cost of surface treatment of the macadam roads in the Washington parks under that office from July 1, 1910, to June 30, 1911, oil or tar being the material used:

No. of road.	Material used.	Quantity. Gallons.	Area of road. Sq. yds.	Length of road. Feet.	Sq. yds treated per gal.	Cost of oil and applying per sq. yd. Cents.
1	Oil	2,300	7,500	1,300	3.26	‡2.8
2	"	4,000	19,000	3,500	4.75	†2.2
3	"	1,000	3,400	650	3.40	†2.7
4	"	700	8,600	2,300	12.23	†1.2
5	"	5,000	25,000	5,000	5.00	†2.1
6	"	10,600	43,560	9,000	4.11	†2.2
7	"	3,400	19,450	3,800	5.72	†1.9
8	"	350	4,000	1,200	11.43	†1.3
9	"	1,000	1,680	700	1.68	*4.6
10	Tar	6,000	11,400	3,500	1.90	*4.4
11	"	650	1,500	1,600	2.30	*3.8
12	"	1,600	3,560	1,600	2.23	*3.8
13	"	2,580	7,740	2,800	3.00	*3.1
14	"	2,400	8,100	2,100	3.39	*2.8
15	"	875	2,000	700	2.38	*3.8
Totals		43,455	166,490	38,650	Av. 3.83	Av. 2.5

*1st application. †2d application. ‡2d and 3d applications.

	Cents.
Cost of labor per square yard	0.8
Cost of oil per gallon	6.5
Cost of tar per gallon	6.8
Average cost in past years of watering roads, per square yard	3.2

In the above table the cost of the sand or of the stone screenings used after the application of the oil has not been taken into account, as it is considered part of the cost of repair of the road.

Road No. 1 in the table had been worn down so that the crown had practically disappeared, leaving the road so flat that the water did not readily drain off. This did no special harm in warm weather but the alternate freezing and thawing that occurred during the winter months allowed the heavy traffic to churn up the surface so that it became necessary to give it a second application of oil in the early spring. The small amount of oil applied to road No. 4 was due to the light traffic on this section, while on road No. 8 an unusually heavy application of oil, 1½ gals. per sq. yd., had been made the year before, a few months after the construction of the road. The large amount of oil absorbed by the new road on the first application made only a light second application necessary.

It is only fair to add that one reason why our park roads have been in so much better condition since we started the use of the surface treatment I have described is that we have abandoned the old method of repairing them once a year and now have a system of regular and frequent inspection and repair. Supplies of broken stone, screenings, oil and tar are kept constantly on hand in the vicinity of the roads, and holes and ruts are repaired as rapidly as they develop, usually before they have become large enough to be noticeable to traffic. We have practically no hills on our roads, so the greatest amount of repair work has to be done on the few sharp curves. The roads are also kept clean, being swept by hand sweepers at fairly frequent intervals.

I have confined myself to giving a brief description of the methods we have tried and the results we have obtained in the surface treatment of the roads in the parks within the city limits of Washington. It is almost needless to say that the conclusions we have now reached should not be considered as final or of general application; they represent simply the result of a limited number of experiments carried on for a limited time under the conditions existing in the Washington parks. The value we have provisionally found for "x" in the solution of our road problem may be quite a different one from that arrived at in another locality where the quantities entering the equation are not the same. The whole matter of road construction is in the development stage, and it is only by feeling our way carefully and comparing the results of many and varied experiments that we can hope to approach a final decision.

SELF-PROPELLED CARS.

On Friday evening, January 19th, W. B. Potter, chief engineer railway department, General Electric Company, read a paper on self-propelled cars before the New York Railroad Club. He described his company's gas-electric cars, which weigh 40 tons to 50 tons and are capable of a maximum speed of 60 m.p.h. Electric control and transmission were used to utilize the inherent characteristics of the gas engine to the best advantage and to relieve the engine from mechanical strain and shock. Series-parallel motor control and regulation of the generator voltage gave a wide range of speeds. The tractive effort at the slower speeds was 12,000 lb. or more. As there was no mechanical connection between the engine and driving wheels, the engine could be slowed or shut down without regard to the control system. With the car standing still or moving the power of the engine could be safely applied in either the forward or reverse direction.

Mr. Potter stated that the engine used on these cars had eight 8-in. x 10-in. cylinders and at the normal speed of 550 r.p.m. would deliver 100 kw. to the motors with some margin to spare. The gasoline most used was "painters' naphtha," which could be purchased for about 6 cents per gallon.

The motors, which were standard 600-volt railway machines, were mounted on the forward truck under the engine, thus placing about 65 per cent. of the total weight of the car on the driving wheels. As the traction voltage varied from 200 volts to 800 volts, the current for lighting the car was supplied by a separate gas-electric generating set. The two-cylinder engine of this set also had an air compressor cylinder for supplying compressed air to start the large engine. The cars had both straight and automatic air brakes, the latter for handling trailers. The engine compartment is in the forward end and is about 12 ft. long.

Performance curves of a 70-ft. car, as submitted by Mr. Potter, showed that with stops two miles apart the schedule speed would be about 25 m.p.h. and the maximum speed on level track about 60 m.p.h. He also presented the following table, showing the comparative cost of operating a train of two coaches and a steam locomotive and of a gas-electric car on a daily run of 150 miles, except Sundays, amounting to 3,900 miles a month:

Two-Trailer Steam Train vs. One Gas-Electric Car.

	Steam Train per Mile.	Motor Car per Mile.
Wages of crew*		
Engineer or motorman	$0.0400	$0.0400
Fireman	0.0240	.....
Conductor	0.0280	0.0280
Baggagemaster	0.0183	0.0183
Total wages of crew	$0.1103	$0.0863
*Based on no overtime allowance.		
Fuel, water and engine lubrication:		
Coal for locomotive, 67 lbs. at $2.25 per ton	$0.0750	.....
Water for locomotive	0.0050	.....
Painters' naphtha, 6 gal., at $0.06 per gal.	.....	$0.0360
Engine lubrication	0.0025	0.0050
Other expenses:		
Locomotive, repairs	$0.0850	.....
Locomotive, engine house expenses	0.0050	.....
Coaches (2), repairs and expenses	0.0250	.....
Gas-electric motor car, general overhaul	.....	$0.0215
Gas-electric motor car, running repairs and expenses	.....	0.0210
Other supplies	0.0025	0.0050
Superintendence	.....*	0.0065
Total cost per train mile	$0.3303	$0.1813

*For steam locomotive this is assumed to be included in items of locomotive repairs and engine house expenses.

Saving per train mile	$0.1490
Saving per diem (except Sunday), 150 miles a day	22.35
Saving for twenty-six-day month	581.00
Gross yearly saving	6,970.00

Note.—When no baggage and express is handled and when operating conditions will permit, the gas-electric motor car can be operated without the third man.

Mr. Potter also gave the following table for three months' operation on the Minneapolis, St. Paul, Rochester & Dubuque Electric Traction Company ("Dan Patch" line), which operates five of these cars. The stations on this line are 1.4 miles apart. The figures cover operation over 37.5 miles between Minneapolis and Northfield for July, August and September, 1911.

Three Months' Operation of Gas-Electric Cars.

Number of days actual service	92
Total mileage, five motor cars	39,352
Number of trailers hauled occasionally	1 or 2
Total mileage trailer cars	7,879

	Total.	Per Train Mile.
Total wages of crew	$2,249.40	$0.0573
Fuel and lubrication, engine:		
24,944 gal. of gasoline at $0.062 per gal.	1,534.20	0.0391
755 gal. of gas engine oil at $0.25 per gal.	189.76	0.0048
Running repairs and expenses:		
Total running repairs, material and labor	410.36	0.0104
Car cleaning, materials and labor	135.70	0.0035
Other supplies	81.83	0.0021
Total expenses	$4,601.25	$0.1172

Mr. Potter further suggested certain forms for keeping an accurate record of the cost of operating such motor cars with or without trailers.

In conclusion Mr. Potter said that a special study has been made to secure a light-weight car for this service. The body weighed 28 tons, the trucks 6 tons and the motive power equipment 15 tons, a total of 49 tons for a 70-ft. car. This was equivalent to 1,000 lb. per seated passenger. The gas-electric car had proved very reliable in the coldest weather. The "Dan Patch" line had operated during very heavy snow with the temperature 15 deg. to 30 deg. below zero when steam trains in the same territory were helpless. This line was using painters' naphtha at 5½ cents per gallon.

PUBLIC UTILITIES IN LONDON, ONT.

There is in Canada at the present time a growing movement tending toward the municipal control and ownership of all utilities dependent upon the public for their revenue and existence. In many municipalities the public have acquired the management of these, and in the majority of cases the results have justified the wisdom of municipal ownership. This has been exemplified in a pointed degree in London, Ont., according to a report just issued by the municipal commissioners of that city on the operation of the water works. The report shows an item of $48,398.23 to the credit of revenue account for the year ending November 30th, 1911. The revenue derived from the sale of water totalled $112,588.93, and the receipts from other sources brought the income to the sum of $173,733.88.

The commissioners have been active in new main laying and general improvement to the plant; the sum of $44,000 being spent on mains and new pumping equipment.

During the past year the motive power of the pumping plant was changed in order that the service offered by the hydro-electric commissioners could be used. By this means the expense of operation, although two plants were in use, was reduced to a considerable extent. By the sinking of artesian wells the water pressure was improved to such an extent that the fire underwriters reduced rates on many buildings. The general superintendent states in the outset of the report that the success of the past year is due in a large measure to the system adopted in regard to the submanagement. The department heads have been given a free hand in the selection of their assistants, etc., making each and every departmental head responsible for results, and at the same time allowing no interference on account of political or personal reasons. The superintendent points out that the result of this is to increase a feeling of responsibility and makes the more valuable men take a pride in their work.

It is pointed out during the course of the report that the future will witness important expansions of the system in the direction of Springbank.

INDUSTRIAL WORKS IN INDIA.

The India office has awarded the contract for the steel work required in connection with a state railway bridge near Allahabad, India, to the Phœnix Bridge Company, of Phœnixville, Penn. There was a difference of 26½ per cent. in its bid and the lowest British tender. This company received the contract for the ill-fated Quebec bridge.

THE MATERIAL-LIST METHOD OF STORE-KEEPING.

By R. W. Heafield.

In putting before your readers the main features of this system of storekeeping, I do so with a firm belief that it is one of the simplest, one of the most effective, and, certainly, one of the least expensive systems that can be adopted. Moreover, it is one that is especially adapted to the engineering trade, both electrical and otherwise, though not necessarily confined to that trade.

One of the most commonly used systems of to-day is that known as the Card Index System, and, although successful to a great extent, as its popularity proves, it, nevertheless, has its drawbacks, one of the greatest of which is, that though the Stores Dept., and the Purchasing Dept. (or Order Section), are the two departments most concerned, they work quite independently and each one is ignorant, to a great extent, of the actions of the other. For example: In many instances the storesman (the man who has the actual handling of the material and giving out of same) if appealed to by anyone to say whether a certain article is on order or not, cannot tell you, and the foreman of a shop, or whoever it is who requires that information, has to either go or send to the Order Section to find out particulars. In many instances it happens that the Order Section is quite a distance from the shop, and the time lost by running about is very often an item of considerable importance to the firm. Another thing worthy of consideration is that this system entails the continuous employment of two, and often more clerks, in the Stores Dept., who do nothing but mark off issued material from the shop tickets on to the stock cards, a very tedious operation and one that is carried on day after day, week after week, all the year round, and, more often than not, results in a man leaving the place just as he has become thoroughly used to the work. Now, this Card Index System is supposed to give a correct statement of the amount of all material in hand or on order. This is the case theoretically, but, in practice, it is found to be faulty and, from time to time, it is found that there is a shortage of stock when the card shows a considerable amount to be in stock, so that the system becomes unreliable.

Now, it is not claimed that the Material List System is infallible, but it is claimed that it does away in large part with the above disadvantages, and, moreover, it gives a greater interest in their work to the storesmen who handle the actual stock.

Upon the securing of an order (or contract) the Engineering Dept., through its Material List Section, shall issue a material sheet or sheets, setting out in detail the quantities of material required. As a rule, no material is ordered or work started until the material list is issued. The material list is first sent direct to the general storekeeper, who shall be responsible for the marking thereon what is in stock and what is not. He shall then forward the material sheet to the Order Section, who shall issue orders for all material not carried as stock. The marking of these sheets may be left to the second man when the storekeeper is too busy to attend to same personally.

The following illustration shows a sample material list.

S. signifies stock.

M.O.S. signifies material on order for stock.

S.P.A. signifies stock part altered.

Z. does not concern stores. Order Section order this to the contract No.

This system gives the storekeeper an opportunity of using up old and perhaps otherwise worthless material, as in the case of the item marked S.P.A. He may have bolts of say 1¼ in. diameter by 14 in. long, which could be cut down and screwed at less cost than the making or purchasing of new bolts. It also enables the shop foreman to see at once what material is on order with the probable time of its arrival and enables him to plan his work accordingly.

When the material list is passed on to the Order Section they shall order all items marked X, marking on the material list the number of the requisition and the date of ordering. The material list was then passed on to the blue print room, for copies to be taken for distribution to the shops building the apparatus, the general storekeeper and all subsidiary storekeepers interested. It should be borne in mind that the shops draw their material from stores in the exact quantities specified on the material list.

CONTRACT APPARATUS — D.L. No. — C.L. No. — Sg'd — Ch'd — Mat. List No. — Date — Sheet

Item	Name of Part	Drg. No.	Pt. No.	Description	Material	No. Reqd.	Remarks	Change
1								
2	Bolts	B 246	4	⅛in. x 2¾in. bright. hex.	Steel	20	S.	
3	Fulcrum Brkt.	"	2	¼in. x 2in.	M Steel	1	M.S.	
4	Bushings	"	6	⅞in. od., ½in. hole, 1in. long	Fibre	2	M.O.S.	
5	Bolts	"	9	1¼in. dia. x 10in. long	Steel	4	S.P.A.	
6	Set Screws	"	10	¼in. x ¾in. cup hd.	"	20	S.	
7	Lubricator	"	15	Meltor's Mechanical	Brass	1	x	
8								
9								
10								
11								
12								

Assuming that we are dealing with a firm which employs from 4,000 to 5,000 men, there will be required considerable sized general stores, besides a number of subsidiary stores, all under the supervision of the general storekeeper. In the general stores there will be employed probable six (6) or more men; and for the sake of illustration, we will divide the general stores into two sections: 1st, bright goods; 2nd, black goods; with an equal division of all raw material, such as fibre, vulcanite, brass, copper, etc., etc. The two most capable men should be selected as the heads of these two sections. Each should be made responsible for any shortage of material in his section, and the watchword in stores work should be thoroughness and efficiency.

Each bin should be provided with a card suspended on a hook. These cards take the place of those used in the Card Index System. On these cards is kept a faithful

record of all material received, the date of receipt, and the requisition number it was ordered on. So strict a record need not be kept of issues, however, especially as regards bolts, nuts, washers and things of little value, as the date of receipt of the last consignment gives an idea of the quantity used in a given time, but in the case of instruments and anything of exceptional value, such as gold, silver, platinum, iridium, quartz, etc., it is necessary that a correct record be kept of all issues together with the contract number issued on. All invoices, whether for stock or contracts should be passed by stores, and all cards marked accordingly. This will be found to be a very considerable advantage in stocktaking, and is necessary to the successful carrying out of the system of debit and credit between the several shops stores and costs department. Debit and credit, however, do not concern us in this article.

A specimen card is given below:

A. B.				E. Co.			
RECEIPTS				ISSUES			
Date	No. Rcd.	Req. No.		Date	No.	Contract	

A red card hung on the hook over the white card indicates that material is in order, and prevents reports of "material wanted" being duplicated.

When the storesman considers it necessary to replenish any article of stock he should requisition more on a form similar to the following, keeping a carbon copy of same.

10-1-12.

STOCK REQUISITION.

Quantity	Article	Delivery	Last Req.	Remarks
200	Bolts ½ x 3 in. Bright Hex.	7 days	42681	
144	L'gts Br'ss Rod ¾ dia. x 10 ft. long	21 days	49763	
10 lbs.	Eureka Wire .0625 dia.	14 days	21364	

He then enters these items in a day-book after the style shown at head of next column.

When the delivery of any particular item is completed he shall draw a line in red ink through that item, but when only part delivery is made, the number or weight of such material shall be recorded in the remarks column.

The storesman can thus tell at a glance, when requested for information, as to whether a certain article on order has come in and whether or not the order is completed. If not in, he can tell when delivery is expected. He is, also, able to obtain his last requisition number from this book, which

Date	Article	Recd. No.	Date Recd.	Req. No.	
10-1-12	200 Bolts ½ x 3in. Bright Hex	200	18-1-12	50264	
"	144 len's Brass Rod ¾ dia x 10 ft. long	100	30-1-12	50265	44 shrt.
"	10 lbs. Eureka Wire .0625 dia.	10	26-1-12	50270	

is really a double check on the stock cards on the bins. This last requisition number is always given in ordering new material, as it is of invaluable assistance to the order section.

The subsidiary stores shall follow a similar course and each responsible storesman shall come to the head storekeeper every morning with requisitions made out. The general storekeeper shall initial all requisitions passed. If he considers any item thereon unnecessary, or in excess of what should be ordered, he shall withhold his signature until he has made personal investigation. All requisitions passed shall be sent without delay to the Order Section.

In addition to the stock material handled as above, the general stores has to receive and distribute, as wanted, all the special material ordered for apparatus being built on sales order and contracts.

A certain section should be allotted for such material in each stores, and a contract book should be kept for the purpose of recording this material in as it arrives and its location in the stores.

This can be indexed in the usual way, keeping the contract numbers in numerical order. Although generally one page suffices for each contract, in the case of a large order two or more may sometimes be found necessary. Outside of steam turbine or locomotive work, however, this is seldom the case.

The above outline covers the procedure of stock-keeping in its chief details; the minor details and changes will have to be worked out to meet the peculiar needs of the work involved.

If properly followed and manned, no embarrassment should arise from the dismissal or enforced absence of any particular individual connected with the department, as each member is more or less familiar with all the routine work.

Like all other systems, this requires alertness and unremitting attention on the part of the head storekeeper and his staff. Great emphasis must be placed upon the proper and reliable marking of the material list sheets; also to the proper checking and recording of goods received.

The writer has worked this system in two large firms with great success. In one firm it was adopted during his employment by them, consequently he worked it from its very inception.

A NEW SOURCE OF CANADIAN GRAPHITE.

Recent exploration has unearthed a large deposit of graphite in the Queen Charlotte Islands, off the coast of British Columbia. The main load appears on the Juskatia Inlet.

A STEAM WAGON FOR HAULING AND CONSTRUCTION WORK.

The wonderful sales and uses found for the gasoline trucks will shortly be competed with by a new steam truck being introduced into this country by Messrs. Jones and Glassco, of Montreal, who have kindly supplied us with this information.

The manufacturers of these trucks are Fodens, Limited, of Sandback, England, who have brought the steam propelled vehicle to a high state of perfection and utility.

Figure 1 is a side representation of one of these machines, and gives a general idea of the appearance and mechanical make-up.

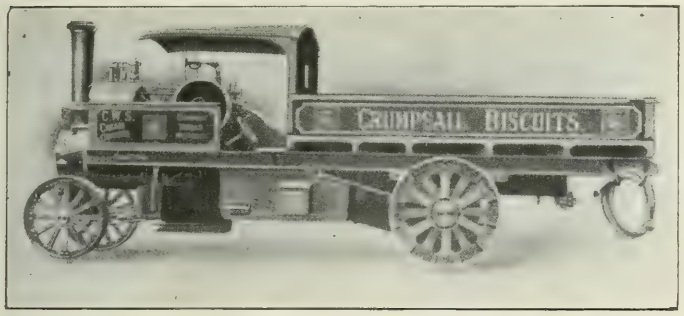


Fig. 1.—Steam Wagon.

Use has been found for these wagons in many diverse occupations in England and there is no reason why they should not compete with trucks driven by other means in this country.

The general design of this wagon is of a novel and original character. The boiler, which is of the horizontal multitubular type, forms the front part of the frame work. The sides of the frame are constructed of strong channel steel tied and braced together in such a manner as to secure great strength in the complete lorry. The platform of the vehicle is 14 ft. long by 6 ft. 6 in. wide. The boiler is fired with coke, hard coal or wood, and is without doubt the easiest steam maker of any boiler or any motor wagon. The wagon is driven by a compound steam engine fixed on the top of the boiler, so as to be readily accessible, and to work with "dry" steam. The cylinders are 4⅜ in. and 6¾ in. diameter, and are fitted with a patented high-pressure gear, by means of which both cylinders can, in case of emergency, receive live steam from the boiler, and each cylinder exhausts independently into the chimney. The reversing motion is of the ordinary link type, and the whole construction of engine and steering arrangement is so similar to the "Foden" traction engines, that any ordinary traction engine driver can easily handle the wagon. The power is transmitted by a pair of spur wheels acting on a compensating gear by an extra strong Renold roller chain. The gearing is arranged for two speeds—9 to 1 and 24 to 1. The car is mounted on laminated springs, and is capable of taking a load of 6 tons on itself and 3 tons on a trailer at an average speed of 6 miles per hour, and can travel 20 miles without taking up water. The fuel carrying capacity allows the apparatus to travel 40 miles on one loading. It can climb a hill (with slow speed) of 1 in 6 with full load. The traveling wheels are extra large, front wheels 2 ft. 9 in. by 6 in. on face, back wheels 3 ft. 6 in. diameter by 10 in. on the face, and so constructed that frost pins and paddles can be used. The tires are constructed of steel, thus doing away with the expense attached to rubber tires. The body is so constructed that the back portions may be tipped for rapid unloading; this can be accomplished by hand or from a belt driven from a flywheel. The back wheels can be made up to 14 in. on face for soft roads.

There are many points of advantage for this machine claimed by the agents and manufacturers over the gasoline trucks; among these the first to be noticed is the cost of operation; an important item to contractors and other large haulers of merchandise.

A large brewery reported a test and statement of a trial of this wagon as follows:—

Goods carried.....763 tons (2,000 lb.)
Total mileage.....2,255
Coal consumption .....2 tons 1,236 lb.
Coal consumption per mile..18.28 lb.

The management of a large leather mill report:—

154 miles per week average distance covered.
Average load .....7.75 tons
Cost per week $24.30
Cost of same haulage by horse $149.64

The management of a brick yard report that a truck of this description has transported 5,000 ton of brick over very rough country with a coal consumption of 40 tons, 640 pounds. The distance of this haulage was 6,000 miles and repairs to the machine during the year of operation totalled $115.38

This company state that they could not have attempted to do the work with horses that the steam wagon did, as the cost would have been far and away too great, and it would have taken eight good horses to do it, the greater portion of the work being beyond horse work altogether. The brick hauling accomplished by these trucks is one of the heaviest and roughest jobs an engine can be put to, owing to the unfinished condition of the approaches to the building, where the materials are to be delivered.

It will be noticed from the second illustration that these wagons differ in many points from steam tractors now in use in this counry inasmuch that the design has been

Fig. 2.—Steam Wagon.

carried out so as to give as much space as possible for the placing of merchandise and other goods, and that the space occupied by the boiler is much less than that of an ordinary tractor

The British War Office have recently turned their attention to the use of these machines for the betterment of their department, and following we give the summary of trials carried out by the officials of that department in order that the most economical means of heavy haulage could be ascertained.

The wagon entered by the Foden manufacturers went through the road trial of 257 miles without a mishap or stoppage for repairs, and was, on the conclusion of the trial, awarded the prize of £250.

Foden.

Date.	Miles.	Time.	Fuel.	Water.	Radius of action.	Fuel consumption. per ton-mile of useful load.	Diameter of turning circle.
5th	30	5 hr. 45 min.	419 lbs.	227 gals.			
6th	30	4 " 45 "	359 lbs.	205 gals.			
9th	31.7	5 " 16 "	392 lbs.	223 gals.			
10th	31.7	5 " 11 "	419 lbs.	253 gals.			
11th	32.6	4 " 40 "	393 lbs.	238 gals.			
12th	32.6	5 " 22 "	324 lbs.	273 gals.			
13th	34	5 " 27 "	400 lbs.	234 gals.			
14th	34	5 " 17 "	402 lbs.	256 gals.			
	256.6	41 hr. 43 min.	3,108 lbs.	1,909 gals.	19 54 miles	2.42 lbs.	12 yds.

Nearest Competitor.

Date.	Miles.	Time.	Fuel.	W ater.	Radius of action.	Fuel consumption. per ton-mile of useful load.	Diameter of turning circle.
5th	30	5 hr. 52 min.	565 lbs.	353 gals.			
6th	30	5 " 21 "	628 lbs.	342 gals.			
9th	31.7	5 " 43 "	647 lbs.	382 gals.			
10th	31.7	5 " 39 "	672 lbs.	311 gals.			
11th	32.6	5 " 14 "	502 lbs.	480 gals.			
12th	32.6	5 " 18 "	669 lbs.	405 gals.			
13th	34	5 " 38 "	648 lbs.	401 gals.			
14th	34	6 " 1 "	667 lbs.	381 gals.			
	256.6	44 hr. 46 min.	5,088 lbs.	3,055 gals.	15.74 miles.	3.95 lbs.	18½ yds.

The trials at Aldershot have shown that these steam lorries are good and serviceable machines, suitable for present supply, and likely to be of great advantage to the transport service in countries where fuel and water in sufficient quantity is available.

Compared with horse draught, these trials have shown that self-propelled lorries can transport five tons of stores at about six miles an hour over very considerable distances on hilly average English roads under winter conditions. The load transported by each single lorry (five tons), if carried in horse wagons of service pattern would overload three general service wagons, requiring twelve draught horses, besides riding horses, whose pace would not ordinarily exceed three miles an hour. Moreover, the marching of 197 miles in six consecutive days over hilly roads would not have been accomplished by horses even at that speed without the assistance of spare horses.

There are a number of these wagons in use in Canada, and of these twelve are in Montreal, three are on order for Toronto concerns, and there are several more in the West.

The London County Council have purchased a number of these Foden trucks and the corporation of Denbigh have had one constructed for street watering with complete success.

IRON AND STEEL INDUSTRY.

The total shipments of iron ore in 1911 are reported as 210,344 tons, valued at $522,319. These may be classified as magnetite 72,945 tons, and hematite 137,399 tons. In 1910 the total shipments were 259,418 tons comprising magnetite 127,768 tons; hematite 130,380 tons and bog ore 1,270 tons. Exports of iron ore from Canada during 1911 are recorded by the Customs Department as 37,686 tons, valued at $133,411. The exports were chiefly from Bathurst, New Brunswick.

The shipments from the Wabana mines, Newfoundland, in 1911 by the two Canadian companies operating there were 1,181,463 short tons, of which 765,184 tons were shipped to Sydney and 416,279 tons to the United States and Europe.

The total production of pig iron in Canadian blast furnaces in 1911 was 917,535 tons of 2,000 pounds, valued at approximately $12,306,860 as compared with 800,797 tons, valued at $11,245,622 in 1910. Of the total output in 1911, 20,758 tons were made with charcoal as fuel and 896,777 tons with coke. The classification of the production according to the purpose for which it was intended was as follows:—Bessemer 208,626 tons; basic 464,220 tons; foundry and miscellaneous 244,686 tons.

The amount of Canadian ore used during 1911 was 67,434 tons; imported ore 1,628,368 tons; mill cinder, etc., 30,298 tons. The amount of coke used during the year was 1,121,321 tons comprising 543,933 tons from Canadian coal and 577,388 tons imported coke or coke made from imported coal. There were also used 1,190,459 bushels of charcoal. Limestone flux was used to the extent of 625,216 tons. In connection with blast furnace operations there were employed 1,778 men and $1,097,355 were paid in wages.

The total daily capacity of 18 completed furnaces was according to returns received 3,630 tons and the number of furnaces in blast December 31, 1911, was 12.

The production of pig iron by provinces in 1911 was as follows:—

Provinces	1911 Tons	Value	Value per ton
Nova Scotia	390,242	$4,682,904	12.00
Quebec	658	17,282	26.34
Ontario	526,635	7,606,674	14.44
Total	917,535	$12,306,860	$13.41

The exports of pig iron during the year are reported as 5,870 tons, valued at $271,968, an average of $46.33 per ton. Probably the greater part of this is ferro-silicon and ferro-phosphorus, produced at Welland and Buckingham respectively.

There were imported during the year 208,487 tons of pig iron, valued at $2,610,989 and 17,226 tons of ferro-manganese, etc., valued at $429,465.

The production of steel ingots and castings in 1910 is reported as 876,215 tons of 2,000 pounds of which 861,493 tons were ingots and 14,722 tons castings. The production in 1910 was 822,284 tons, including 803,600 tons of ingots and 18,684 tons of castings.

The production of open hearth and Bessemer steel has been for three years as follows:—

	1909 Tons	1910 Tons	1911 Tons
Ingots—Open-hearth (basic)	535,988	580,923	651,676
Bessemer (acid)	203,715	222,668	209,817
Castings—Open-hearth	14,013	18,085	13,982
Other steels	1,003	599	740
Total	754,719	822,284	876,215

THE PANAMA CANAL.

Mr. William McNab, principal assistant engineer of the Grand Trunk Railway system, recently returned to Montreal from the Panama Canal, where he went for the purpose of inspecting the engineering plant used, as well as other features connected with the undertaking.

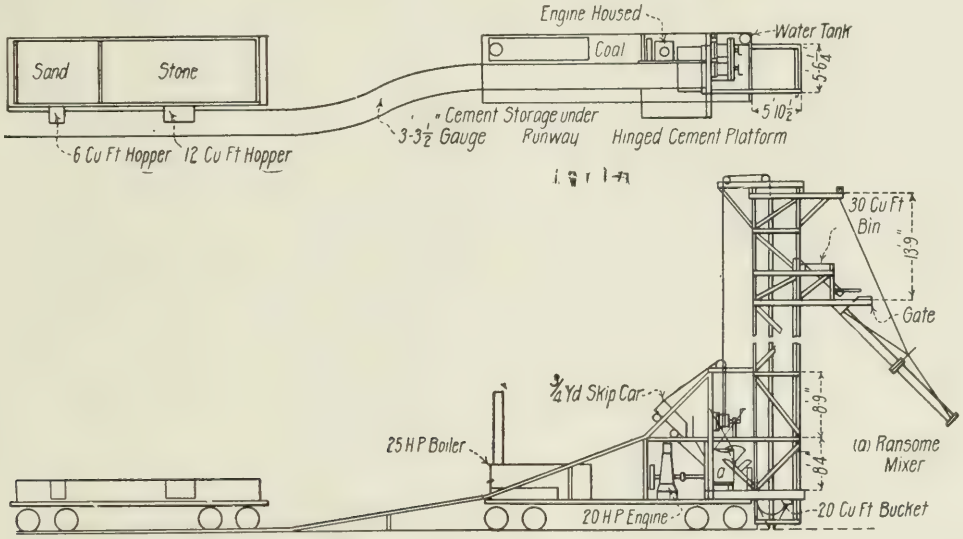
"In regard to the economics of commerce," said Mr. McNab, "there can be little doubt but that the canal will in general create an entirely new situation. Its operation will not only form new geographical features and substantially modify the complexity of the world's commerce but it will be an element of such importance that its influence will be universally felt in a more or less degree in every branch of trade. The North will be nearer and in closer relationship to the South and the South will be closer to the North. The Central American republics, too, which hitherto have been an uncertain feature in modern business and social life, will be found to fall in line with and share in such development. The fruit districts of Central America and the West Indies will also undergo rapid expansion in meeting the new order of things.

"It is unnecessary at present to quote saving in distance in certain existing sailing routes which will be effected after the canal is in use. It is obvious, among other things, that rapid growth of Pacific ports may be looked for.

"In regard to how the several transcontinental railways will be affected by the existence of the canal and the traffic it will carry, it is obvious that the most northerly ones will specially derive a direct benefit from it. The wheat fields of Western Canada are practically only beginning business, and at no far distant date will be a main source of supply of breadstuffs for not only Europe, but for the Southern States and West Indies as well. The problem of handling the fall crops in one direction within a reasonable time will then be felt. The Grand Trunk Pacific with its low gradients will be in a position to distribute its business to advantage, and take westward from Saskatchewan and Alberta a fair share of the agricultural output of these provinces for shipment via Prince Rupert and the canal."

AN EFFICIENT CONCRETE PLANT FOR RAILROAD WORK.

The accompanying line drawing shows a concrete plant which has been used with much success by a southern railway company for constructing abutments, retaining walls, culverts, etc., along its right-of-way. With a ¾-yard Ransome mixer driven by a 20 h.p. engine, 288 cu. yds. of concrete have been mixed in nine hours. The additional h.p. of the mixer engine is required to operate the hoist and the ¾-cu. yd. skip car. Steam is furnished by a 20 h.p. boiler.



An Efficient Concrete Plant for Railroad Work.

In order that the work of unloading may go on without the necessity of keeping the skip car from taking its load of material to the mixer, quick unloading chutes are attached to the flat cars in which the sand and stone are received. The skip car runs on an industrial track that is laid up an incline to the mixer. The section of the track between the end of the mixer car and the ground is hinged so that it can be quickly swung up when it is necessary to move the plant and two or three sections of the track can be readily picked up and thrown on the flat car. The skip car discharges into the fixed batch hopper of the Ransome mixer which in turn discharges the finished concrete into a 20-cu. ft. bucket, located in a wooden hoisting tower. The concrete is raised in the tower to a 30-cu. ft. concrete hopper with a Ransome gate. From here the concrete enters the swinging chute and runs to the point desired.

It will be noted that the entire plant is portable, the flat car having mounted on it the boiler, engine, mixer, and tower, while space for coal and water tank is provided. The entire plant was designed by the Ransome Concrete Machinery Company.

Metallurgical Comment

T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

SOME ENGINEERING FEATURES OF ELECTRIC FURNACES.*

By Carl Hering.

As it is such a simple matter to convert electric energy into heat, electric furnaces have to a large extent been designed and constructed by metallurgists and chemists rather than by engineers,† almost any crude electric contrivance will produce heat, and hence was good enough; the main question was: Will it perform the necessary metallurgical, physical or chemical reactions? Now that the latter has been demonstrated beyond question for a large variety of processes, the inevitable question naturally arises, will it pay to use electric heat? To determine this it becomes necessary to design and construct the furnaces so that they will have the highest possible heat efficiency; that is, to reduce the inevitable heat losses to the least possible. This is of far greater importance for electric furnaces than for those using the combustion of fuel, as the cost of a unit of heat is generally considerably greater when produced electrically than when generated directly by combustion. Fuel furnaces are, as a rule, so very wasteful that their design is of little or no aid in designing electric furnaces. The important problem of to-day, therefore, in connection with electric furnaces, is that of their design and construction so as to make them as perfect an engineering structure as possible; hence it falls into the province of the engineer as distinguished from the chemist or metallurgist.

The study of the flow of heat through bodies does not seem to have been given the attention which it deserves. A postage stamp pasted on the fireside of a steam-boiler tube will not even be charred by the flames, showing the existence of an enormous resistance to heat flow on the outside of the tube; a study of the phenomenon of the flow of heat showed how the resistance can be diminished, resulting in a much greater flow, hence increased steaming capacity. An excessive heat insulation of a gas-engine cylinder would result in its destruction. The over-insulation of steam pipes, which is said to be quite common practice, results in the waste of more money for the covering than the saving in steam warrants. All such engineering problems would be simplified by giving this subject of the flow of heat more attention. The lack of proper units and physical constants for such calculations is doubtless responsible in part for the neglect of due consideration of this branch of engineering.

In general, there are two classes—resistance and arc furnaces. In the former the heat is generated in the interior of a conductor, due to the resistance offered by the material to the passage of a current through it. The ordinary incandescent electric lamp is a simple illustration of the generation of heat in this way. In the arc furnaces the heat is generated by the passage of a current through a gap formed between the ends of two conductors; the bridging of this gap by the current is called the electric arc. The ordinary arc lamp used in streets and halls is a simple illustration of the generation of heat in this way.

In the resistance furnace the current may be passed through the material itself which is to be treated, or it may be passed through a permanent near-by conductor, and transmitted to the material to be treated by radiation, conduction, and convection.

When the heat is generated in the material itself, the heating becomes very efficient, practically 100 per cent. as all the heat is generated in the body itself, where it is wanted. This is therefore the most efficient method; it is also generally the most rapid, as no time is lost for the heat to penetrate by the slow process of conduction, from the outside to the inside; it is all in the inside when it is generated, and it can be generated very fast by simply increasing the current. Hence in some respects it is the ideal method. As long as the material remains solid, there is apparently no limit to the temperature which may be reached, for by continuing the passage of the current, heat continues to be generated, and if it cannot escape, it accumulates, thereby continually raising the temperature until the losses equal the input. This is the case in the graphite and carborundum furnaces, in which exceedingly high temperatures are obtained, estimated to be from 2,300 deg. C. to 4,000 deg. C. (4,000 deg. F. to 7,500 deg. F.)

If, however the material through which the current passes becomes liquid, generally in an open channel, there is a very decided and sometimes very serious limit to the temperature which can be produced, for when the current reaches a certain value, dependent on the cross-section and the density of the material, a formerly unrecognized force comes into play, which contracts the column of liquid until it is severed completely, and this, of course, interrupts the current. This peculiar phenomenon was encountered, studied, and described by the writer some years ago, and termed by him the "pinch phenomenon," by which name it is now generally known here and abroad. By submerging these channels of liquid deeply below the surface, the writer found that this pinching force may not only be prevented from interrupting the circuit, but may even be used to cause the liquid in the confined channel to flow out of it as quickly as it is heated, whereby it also produces much desired circulation. Such a furnace, then, has the desirable qualities of one with solid registers, besides some new qualities due to the rapid circulation of the heated liquid.

The characteristics of the arc furnaces are briefly as follows: The temperature of the arc is always that of the volatilization of the material of the electrodes between which the arc plays, and as these are generally carbon or graphite which have extremely high vaporization temperatures, it follows that the temperature developed in such arc furnaces are exceedingly high—generally far above what is required. This heat is, however, all generated in the arc itself, and at the surfaces between which the arc plays; hence it can reach the main body of the material to be treated only by radiation, conduction, and convection, and this necessarily takes time; the exceedingly high arc temperature aids this. In heating liquids with an arc, much of the enregy must necessarily radiate upward, hence is not utilizied, and even tends to destroy the roof of the furnace. Moreover, heating a liquid from the top surface is not the most rational way, as the heat travels downward with difficulty and quite slowly, hence taking time for the heat to penetrate; this is also the case in open-hearth furnaces. The electrodes in arc furnaces are consumed, and

* From a Paper read before the Engineers' Club of Philadelphia.

† The significance of this statement should be recognized. Metallurgists are more and more being called upon to display constructive ability.—Ed.

therefore require continuous feeding, or else the arc goes out. Some, and perhaps a considerable amount, of the electric energy, for such furnaces is necessarily consumed in volatilizing the electrode material, although part of this may be again recovered.

Heat is generated by the current in the electrode; this, generally being at a lower temperature than the interior of the furnace, flows out at the cold end. As long as the end of the electrode which is in the interior of the furnace is cooler than the heated product under treatment, heat must necessarily be abstracted from this product, and will flow out through the electrode, thereby chilling the product. This latter loss of heat could be stopped entirely if the hot end of the electrode were at the same temperature as the heated product, for heat will flow only when there is a difference of temperature. If, therefore, the electrode is given such a cross-section and length that the heat generated in it by the current raises the inside end to the furnace temperature, then this desired result of stopping this abstraction of heat from the furnace product will be accomplished.

Former practice had led to making the electrodes larger and larger, to keep them cool; this made them more and more costly and more difficult to handle. They should have been made smaller instead, so as to stop the loss of heat from the furnace product where it is wanted; the heat generated in the electrode costs less than in the furnace, as it has to be transmitted (as electric energy) over a shorter distance. Such reductions in the size of electrodes result in large annual savings, not only of power, but of electrode materials also. And it increases the valuable available space in the furnace by not chilling a more or less large part of the product.

Formerly it was claimed very positively by certain parties that graphite was a worse material to use than carbon, on account of its much higher heat conductivity; it was claimed to "chill the product too much," and therefore very wasteful of energy. The above analysis showed that this too was an error, as this chilling may be entirely prevented by proper proportioning; and when thus proportioned graphite is even less wasteful than carbon.

The explanation of this is that the minimum losses and the best proportions do not depend on either the electric or the thermal conductivities alone, but on certain relations between them. Neither property alone is a criterion. This brought out the surprising fact that the best electrode materials, from the standpoint of the least possible electrode losses and the smallest amount of electrode material were the metals; and of these, copper, the best of all heat conductors was decidedly the most economical. Hence, electrodes should be made of metals whenever possible, if economy of power and material is an object. This gives the resistance furnace an important advantage over those using the arc.

Although, as a rule, electric heat is more expensive than fuel heat, yet in electric furnaces it is generally possible to apply the heat much more economically, and greatly to reduce the thermal losses, by proper and careful design, so that the total cost of the thermal operation in many cases becomes less, and that is after all the deciding factor in most cases. When a furnace is properly designed to reduce the thermal losses to the least possible, it is believed by the writer that it will soon be economical to replace some of the present fuel furnaces by electric furnaces for commercial work, even when the electric power has to be purchased from the supply in cities. There are, of course, other factors involved also, such as the reduction of labor, the better quality of the materials produced, the rapidity of heating, etc., all of which should be taken into consideration.

COMPETITIVE CONDITIONS BETWEEN THE OPEN-HEARTH FURNACE AND THE BESSEMER CONVERTER.*

The progress of the open-hearth process may be explained from different points of view. As far as raw materials are concerned, the converter requires a pig-iron the composition of which must only vary within relatively slight limits, and the economical production of which thus depends on the natural conditions of deposits which are not met with in all iron and steel districts. On the other hand, the open-hearth process accommodates itself to very diverse working formulæ, and the proportion of pig-iron in the charge being capable of variation within the widest limits—from 100 per cent. in the ore process, where the charge does not permit of scrap, but only of pig-iron with the corresponding quantity of ore down to 30 per cent. and even 25 per cent. in the scrap process.

In the case of districts with ore moderately phosphoric, giving a "bastard pig," containing, for instance, 0.8 to 1 per cent. of phosphorus, it does not appear a priori impracticable to make basic pig by embodying in the charge a calculated percentage of phosphoric additions. Once the process was permanently established for the whole of the works (blast furnaces and steel works), such phosphoric additions could naturally be furnished by the scoria of dephosphorization itself. The basic process is, therefore, not necessarily limited to districts supplying ore of the basic class, such as the minettes in Lorraine; whilst, on the other hand, the Bessemer process is only possible when hematite ores are available. The progressive diminution of the reserves of hematite ores in the world consequently tends to restrict more and more the possibilities of the Bessemer, and, at the same time, those of the acid open-hearth processes.

With due acknowledgments of the qualities of basic Bessemer steel when properly manufactured, it must be recognized that open-hearth steel presents, cœteris paribus, a greater regularity of quality, and appears best suited for certain manufacturers, such as boiler-plates, tyres, axles, forgings, tubes etc., as well as for all pure and semi-pure steels in general and special steels. The great elasticity of the open-hearth process may also be pointed out. On the other hand, the process is disadvantageous owing to the relative slowness of furnace refining, and the price of open-hearth steel is generally higher than that of converter steel. In this connection, the price of producer coal forms an essential element in the cost of refining in the open-hearth furnace.

The United States.—The contest in the United States is limited to the Bessemer and open-hearth processes, the latter gaining on the former year by year. Two principal facts dominate the situation. On the one hand there are the growing demands on the part of consumers (particularly by the railways) from the standpoint of the purity of the metal, and on the other the content of phosphorus in the red hematites from Lake Superior. These great deposits—which have already yielded over 300,000,000 tons, and the reserves of which are still estimated by the United States Geological Survey at 3,500,000,000 tons, furnish about three-fourths of the American production of iron ore. The deposits, moreover, constitute the most important reserves, in the country, as the resources at present available are only estimated (the Stockholm Congress of Applied Geology) at 4,250,000,000 tons for the whole of the United States, of which the Lake Superior district is credited with 82 per

* Bulletin of the Société de l'Industrie Minerale.

cent. But these deposits furnish an increasing proportion of non-Bessemer ore; that is to say, too phosphoric for the manufacture of pig-iron for the acid Bessemer process. It is known that the maximum phosphorus content allowed in the ore in America for Bessemer treatment has been 0.044 per cent. for a long time past, which, with a yield of 50 per cent. of iron corresponds to about 0.09 per cent. in the pig-iron and 0.1 per cent. in the steel. The tonnage of Bessemer steel rails supplied in 1910 was only 1,949,000 tons, as compared with 3,434,000 tons in 1907, whereas the quantity of basic open-hearth rails, which was only 257,000 tons in 1907, rose to 1,743,000 tons in 1910.

Thus, through the natural conditions of the ore deposits and the greater exigencies of consumers there is a progressive diminution of the possibilities of the converter to the advantage of the basic open-hearth furnace, which has for several years furnished more than one-half of the production of steel. As for the acid open-hearth process, which depends on the scrap market, its prospects are most restricted. It is usually reserved for the manufacture of pure and semi-pure steels, with pig-iron having a very small content of phosphorus—much purer than those readily used with the Bessemer process. Thus its percentage seems likely to decrease.

Whether the basic converter will ever be established in the United States seems more than doubtful. The principal ore deposits do not yield basic ore, and the non-Bessemer hematites from Lake Superior, which are too impure for the acid converter, are much too poor in phosphorus for the manufacture of pig-iron for basic conversion. Suitable ores could only be found in some secondary deposits of relatively low production and limited reserves. Moreover, none of them appears to possess hitherto the regularity of phosphorus content which characterizes the oolitic deposits in Lorraine, and which constitutes a condition which is so essential for the economical manufacture of basic pig-iron. It therefore does not seem in the present condition of the deposits that the basic process is destined to play an important part in the American iron and steel industry.

Germany and Luxemburg.—The situation in Germany and Luxemburg is very different. The perdominance of the basic process is explained when it is considered that four-fifths of the iron ore produced in the Customs Union, the total of which amounted to 28,700,000 tons in 1910, are yielded by Alsace-Lorraine and Luxemburg; that is to say, by the minette region which exclusively supplies basic ores. Excluding the annexed portion of Lorraine and the Grand Duchy of Luxemburg, Germany proper scarcely furnishes from 5,000,000 to 6,000,000 tons, and one of her most productive deposits—that of Ilsede—yields basic ore. The output of ore in Germany, including Luxemburg, is considerably less than the consumption, and the difference between the two figures tends to increase in the direction of growing imports. In 1910 the production reached 28,710,000 tons, the imports 9,817,000 tons, the exports 2,953,000 tons, and the total consumption 35,574,000 tons.

The excess of imports over the exports of iron ore represent at present about one-fifth of the consumption as compared with one-seventh three years ago. Sweden remains the principal country from which ore is imported into Germany, and is followed rather closely by Spain, but the progress made by imports from France has been rapid; they now form 18 per cent. of the total imports as contrasted with 9 per cent. three years ago, and it is possible that they will occupy the first position in the course of a few years. But these imports originate almost entirely from the Briey basic, or minette district. As far as the Swedish ores are concerned, they are mostly phosphoric magnetites, which are largely used by the Westphalian works for the enrichment of their basic charges. The most important deposits in Sweden, both from the point of view of present production and that of the known reserves, are, moreover, those of phosphoric ores. But their importance is secondary as compared with the minette district, the output of which was 36,182,000 tons in 1910, and the recognized resources of which are estimated at over 5,000,000,000 tons. These deposits, which constitute the largest reserves of ore in the world, assure a brilliant future for the basic process both in France and Germany, including Luxemburg.

The production of ore in Luxemburg rather tends to decrease, and that of Lorraine progresses slowly, but that of Meurthe and Moselle is growing with enormous rapidity owing to the development in the Briey basin. However, if the increase in the output in the minette district should be considerable in the near future, the percentage of basic Bessemer steel can hardly increase very much at the expense of that of open-hearth steel. It seems, indeed, that for Germany and Luxemburg the state of equilibrum may be substantially reached between the basic Bessemer and the open-hearth processes, which divide nearly the whole of the production of raw steel. The importance of the acid processes is at present practically nil, being 1.1 per cent. for acid open-hearth and 1.3 per cent. for acid Bessemer, as compared with 37.3 per cent. of basic open-hearth and 60.3 per cent. of basic Bessemer. On the one hand the development of the basic process involves a co-relative development of the open-hearth (scrap) process for the utilization of rolling-mill waste. On the other hand, the open-hearth furnace, working with a high percentage pig-iron, is gaining increased ground even in Germany, owing to the improvements recently introduced in the methods of working, and the advantages offered by the process in districts which only yield bastard ores.

STEEL CASTINGS.

A lecture on "Steel Castings" was delivered before the London branch of the British Foundrymen's Association by Mr. H. Brearly, of the Brown-Firth Research Laboratory, Sheffield.

The lecturer pointed out that the coarse crystalline appearance which the fracture of a steel casting was supposed to have was not now a sufficient distinction between castings and forgings. Examples of the coarse crystalline fractures of steel cast in sand moulds and slowly cooled were exhibited, and also illustrated by lantern slides, side by side with portions of the same casting after heat-treatment. The exposed fractures of the latter were in all respects indistinguishable from well-wrought forgings. The lecture was mainly devoted to the processes involved and the structural changes taking place between these two extremes.

The lecturer emphasized the workshop value of careful observation of fractured and prepared surfaces with a hand lens or any other available magnifying outfit; and then showed by a series of low-power photographs the wonderfuly perfect structure of the interior of separate crystalline grains of mild steel. By the same means the defects arising in and about the crystalline grains were demonstarted, and a clear impression conveyed of the objects to be attained by annealing.

The portion of the lecture which dealt with the fragility of unannealed steel castings was well illustrated and conveyed a clear reason for their erratic behavior. The lecturer thought it highly undesirable that unannealed castings

should be brought into any kind of service where trustworthiness was called for; and showed, quite apart from the question of cooling stresses, how they might be expected to fail and how the important question as to whether or not a casting had been successfully annealed could be determined by simple means. The main object to be accomplished by annealing was said to be the elimination of the coarse crystalline structure, due to cooling from the liquid state, and the substitution of a much finer structure by methods which varied with the composition of the steel. Some very clear slides illustrated the hindrances, which occurred in uncontrollable ways, and prevented the attainment of this object, and led also to that kind of rupture between the crystals known to the foundrymen as pulling.

The pulling of metal as it passed from the fluid to the solid state was only briefly referred to, and illustrated by a few instances occurring in simple shapes usually cast in chill moulds; but more attention was paid to the manner in which castings of varying cross-section might bring themselves to an untimely end during cooling from a red heat to atmospheric temperatures. Alloy steels appeared to be very tricky in this respect, which accounted to some extent for the unwillingness of many manufacturers to utilize them for sand castings. It would appear, however, that the difficulties were of such a kind as could be overcome by intelligent care and close observation.

IRON AND STEEL INDUSTRY IN BRAZIL.

A decree has been passed in Brazil which grants power to Mr. A. Thun, or to a company which he may form, to establish in the municipal district of Ouro Preto, Minas Geraes, blast furnaces capable of producing 50,000 tons of pig-iron annually, this amount to be increased by 10,000 tons until a yearly capacity of 100,000 tons is reached. The plant is also to be suitable for the manufacture of rolled iron and steel. The contract provides for the granting of certain State privileges for the encouragement of the iron and steel industry in Brazil.

QUEBEC'S LANDS AND FORESTS REPORT.

The total revenue of lands and forests amounted to $1,229,928, states the Minister of Lands and Forests of the Province of Quebec, Honorable Jules Allard, in his introduction to a recently published report, for twelve months ending June 30th, 1911. The ground rents due on timber licenses brought in $221,215; the dues on timber cut under such licenses, $821,719; penalties for infringements $44,730; accrued interest $7,798, and bonuses on transfer $31,444, making a total of $1,126,907. On account of greater production the stumpage dues brought in nearly $85,000 more than in the previous year, although the new tariff was not yet applicable. Through the increase in stumpage dues and ground rents and also by reason of the rapid settlement of the public lands, the Minister of Lands and Forests reports that the department is sure of a yearly revenue of nearly $1,500,000. The expenditure of the department includes $85,000 for surveys, $16,523 for protection against fire, and $4,000 for the Forestry School. The salaries and disbursements of forest rangers amounted to $23,546. Woods and forests general expenses amounted to $36,199.

The area under license during the year amounted to 70,138 square miles. The amount of square timber cut was 109,406 cubic feet. The cut of spruce, hemlock, balsam, cypress, cedar, white birch and poplar, saw logs and boom timber totalled 498,624,000 feet b.m. The cut of white pine and other varieties of saw logs and boom timber amounted to 154,429,708 feet b.m. The cut of red pine, saw logs and boom timber, amounted to 21,623,970 feet b.m. The cut of white pine 11 inches and under for saw logs amounted to 62,112,914 feet b.m. The quantity of poles cut was 203,586 lineal feet. The cut of pulpwood amounted to 345,206 cords of 128 cubic feet. Of this quantity 180,803 cords were shipped out of Canada. The cut of firewood was 3,808 cords. Railway ties were manufactured to the number of 608,429, and pickets to the number of 109,734. The cut of shingles amounted to 8,373,000. Spool wood was cut to the extent of 8,981 cords. Of posts and rails, the output was 44,372 pieces, and 755 cords of lathwood were manufactured.

ENGINEERING NOTES.

St. Lambert, P.Q.—The Montreal Harbor Board did not encourage the proposal of this municipality regarding the extension of the sewer from St. Lambert.

Saskatoon, Sask.—The municipal filtration plant is now ready for the placing of the sand on the filter beds. It is expected that the plant will be in operation by May 1st next.

North Vancouver, B.C.—This municipality have commenced construction work on a new reservoir. Rice Lake is being converted for water storage in connection with this project.

British Columbia.—A start has been made on the scheme to reclaim 14,000 acres of fine land in the lower Fraser Valley, south of New Westminster. The cost will be $135,000.

Saskatoon, Sask.—There is serious talk of a forestry station being established near this city. The Dominion Government have allowed $20,000 in the supplementary estimates for this purpose.

Toronto, Ont.—The municipal council have taken the first steps toward the consideration of a new source of water supply for this city. Certain members of the municipal department have prepared a scheme that is expected to do away with the intake, as used at present, and the filtration plant. The plan is to dig a well on the lake shore and allow it to fill with water. The water having filtered through several hundred feet of sand before it reached the well, would be as pure as the most elaborate plan of filter beds could make it. From the well the water would flow to the pumping station at the foot of John Street by gravitation, as it does now from the intake in the lake. It is proposed to have the well from 70 to 100 feet deep, according to the distance required to reach rock-bottom. It will be 50 feet in diameter and will be covered. The well will be simply a big iron pipe faced with concrete. The water will filter into the tank from the bottom. It is estimated the cost of such a well would be $100,000, and that it will supply 18,000,000 gallons of pure water per day. Petrolea and London have tried the plan with great success.

PERSONAL.

Mr. T. H. Bryson, of Pembroke, Ont., has been appointed municipal engineer of Brockville, Ont.

Mr. Albert S. Goodeve, M.P., has been appointed to the Board of Railway Commissioners for the Dominion of Canada.

Mr. Lea, waterworks engineer for the city of Vancouver, B.C., has been granted a leave of absence and will seek a return of his health in the eastern portions of Canada.

Mr. Frederick L. Riggs has been appointed to the position of secretary of the Civic Guild. Mr. Riggs is the manager of the Imperial Construction Company, Quebec Bank Chambers, Toronto.

Mr. George E. Herrmann has been appointed to the management of the Vancouver branch of the engineering firm of Robert W. Hunt and Company, Ltd. The address of the new offices is 415 Bank of Ottawa Building.

Mr. Arthur Scott has been appointed manager of the Dominion Steel Company. Mr. Scott is a graduate of McGill University and has had considerable experience with the chemistry of iron and steel and substances used in their manufacture.

Mr. John A. Bensel, M. Am. Soc. C.E., state engineer of New York, on March 25th delivered an illustrated lecture on "The Construction and Maintenance of the State Roads of New York" before the graduate students in highway engineering at Columbia University.

Messrs. A. W. McConnell, B.A., Sr., and Stanley Makepeace, B.S., have formed a partnership and will enter the practice of architecture with their offices in the Kent Building, Toronto. Mr. McConnell was lecturer in architecture at the University of Toronto, and Mr. Makepeace was a member of the late firm of Makepeace and Makepeace, Syracuse, N.Y.

COMING MEETINGS.

CANADIAN INSTITUTE.—198 College Street, Toronto. Saturday Evening Lectures, 8 p.m. April 13th,—"Lantern Experiments on Reaction in Non-homogeneous Systems," by Prof. Kenrick, Toronto University. April 20th—"Chemical Interpretations of Vital Phenomena," illustrated. Prof. Leathes, Toronto University.

THE CLEVELAND ENGINEERING SOCIETY.—Special Meeting, Tuesday, April 23rd, 1912, Chamber of Commerce Bldg., Cleveland, O. "Steel and its Heat Treatment" (Illustrated), by Robt. R. Abbott, Metallurgical Engineer, The Peerless Motor Car Co. F. W. Ballard, Secretary.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary. Professor C. H. McLeod.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary-Treasurer, R. W. Macintyre

QUEBEC BRANCH—Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—Secretary E. Brydone Jack. Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—Chairman, Geo. H. Webster: Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department. University.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. V. Ross.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment. London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
4-11	Grading, sanitary sewers, cement walks, etc., Lethbridge, Alta.....(P. & S.)	3-14
4-15	Cement sidewalks, Battleford, Sask. ..(P. & S.)	4-4
4-30	Tunnel sewer, Edmonton, Alta. .....(S.)	4-4

(Battleford and Lethbridge plans and specifications are on file at The Canadian Engineer Office, 820 Union Bank Building, Winnipeg.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Battleford, Sask., laying cement sidewalks	Apr. 15.	Apr. 4.	68
Calgary, Alta., concrete structures	May 1.	Mar. 28.	70
Calgary, Alta., designs for aqueduct	May 1.	Feb. 22.	70
Calgary, Alta., steel highway bridges	Apr. 15.	Mar. 14.	68
Edmonton, Alta., tunnel sewer	Apr. 30.	Apr. 4.	72
Goderich, Ont., extension to breakwater and dredging	Apr. 15.	Mar. 21.	70
Hamilton, Ont., water works extension	Apr. 10.	Mar. 28.	72
Holland Island, B.C., lighthouse	Apr. 20.	Mar. 21.	60
Kentville, N.S., academy building	Apr. 15.	Apr. 4.	59
Little Pines, Sask., school house, etc.	May. 6.	Apr. 4.	60
Lethbridge, Alta., grading, sanitary sewers, etc.	Apr. 11.	Mar. 14.	70
Lion's Head, Ont., extension wharf	Apr. 16.	Mar. 28.	60
London, Ont., cast iron pipe.....		Mar. 28.	72
Medicine Hat, Alta., church	Apr. 12.	Mar. 28.	59
Moose Jaw, Sask., water-tube boilers, etc.	Apr. 17.	Mar. 28.	59
Moose Jaw, Sask., supply of coal	Apr. 13.	Mar. 21.	59
Moose Jaw, Sask., cast-iron pipe and specials	Apr. 15.	Apr. 4.	74
Moose Jaw, Sask., sewer pipe and specials	Apr. 15.	Apr. 4.	74
Muncey, Ont., alterations to Industrial School	May. 1.	Apr. 4.	60
Ottawa, Ont., coal	Apr. 10.	Mar. 28.	60
Penticton, B.C., power station	Apr. 18.	Apr. 4.	60
Point Atkinson, B.C., concrete tower, etc.	Apr. 20.	Mar. 21.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Prince Albert, Sask., outfall Sewer	Apr. 15.	Apr. 4.	74
Port Arthur, Ont., fire alarm system	Apr. 15.	Apr. 4.	72
Regina, Sask., water collecting pipe lines, etc.	Apr. 12.	Apr. 4.	74
Sarnia, Ont., wharf and dredging basin	Apr. 18.	Mar. 28.	60
Saskatoon, Sask., sewer pipe	Apr. 19.	Apr. 4.	72
St. Boniface, Man., sewer	Apr. 15.	Mar. 28.	60
St. Jerome, Que., hydro-electric installation		Feb. 7.	68
Sudbury, Ont., sewers, etc.	Apr. 17.	Mar. 21.	60
Swan River, Man., steel bridge.	Apr. 22.	Apr. 4.	74
Toronto, Ont., St. Alban's Cathedral	Apr. 22.	Apr. 4.	60
Toronto, Ont., concrete walks ..	Apr. 19.	Mar. 28.	60
Winnipeg, Man., asphalt wagons.	Apr. 15.	Apr. 4.	72
Winnipeg, Man., machine shop..	Apr. 18.	Mar. 28.	60

TENDERS.

Arborg, Man.—Bulk tenders will be received up till May 1st, 1912, for all of the works and materials required in the erection and completion of a two-roomed school, Arborg. J. P. Palsson, secretary-treasurer, Arborg, Man.

Calgary, Alta.—Tenders will be received at the office of the Canadian Pacific Railway Division Engineer, Calgary, up to noon of April 15th, 1912, for the placing of contracts for subway at Ninth Avenue East, Calgary. Form of tender at Assistant Engineer's office, Strathcona, and Chief Engineer Winnipeg, also N. E. Brooks, Canadian Pacific Railway Division Engineer, Calgary.

Calgary, Alta.—Tenders will be received at the office of N. E. Brooks, Canadian Pacific Railway Division Engineer, Calgary, up to noon of April 22nd, for the placing of concrete for overhead bridge at Anthony Street, Strathcona. Forms of tender at this office, also at Assistant Engineer's office, Strathcona, and Chief Engineer, Winnipeg.

Calgary, Alta.—Tenders will be received up to noon of April 15th, 1912, for the erection of approximately 118 miles of single circuit telephone line in the Eastern Section of the Canadian Pacific Railway Company's Irrigation Block. Full particulars may be had on application. A. S. Dawson Chief Engineer, Canadian Pacific Railway, Calgary.

Edmonton, Alta.—Tenders will be received by the City Commissioners until April 30th, 1912, for the construction of a reinforced concrete sewer. (See Advt. in Canadian Engineer).

Hamilton, Ont.—Tenders will be received at the offices of Munro and Mead, Architects, Hamilton, up till noon, April 12th, 1912, for the various trades required in the erection of a Public school at Burlington, Ont. Plans and specifications may be seen at the offices of the Architects and also at the office of Mr. Blair, Burlington.

Macdonald, Man.—Tenders will be received by H. Grilk, secretary-treasurer, Municipality of Macdonald, until noon on Wednesday, April 24th, 1912, for the grading of about 40 miles of roads in the Municipality of Macdonald, location of which may be seen at the clerk's office, Sanford.

Macklin, Sask.—Tenders for the construction of a four room brick school building, will be received up to April 16th, 1912. Plans, etc., at J. F. Cairns' hardware store, Saskatoon. A. W. A. Corscadden, secretary-treasurer, Macklin, Sask.

Municipality of St. Paul, Man.—Tenders will be received until April 18th, 1912, for the draining and grading to the East two mile road, the Hoddinott road, the East Main road, and the West Main road. Plans, etc., at the Municipal Office at Birds' Hill, or at the office of the Highway Commissioner, Parliament Buildings, Winnipeg. W. Gorman, Secretary-Treasurer, Rural Municipality of St. Paul.

Ottawa, Ont.—Tenders for the construction of a concrete retaining wall at Long Branch Rifle Range, Toronto, will be received up till noon of April 15th, 1912. Plans, etc., at the offices of the General Officer Commanding 2nd Division, 215 Simcoe Street, Toronto; and the Director of Engineer Services, Department of Militia and Defence, Ottawa. Eugene Fiset, Colonel, Department Minister, Department of Militia and Defence.

Ottawa, Ont.—Tenders will be received until April 30th, 1912, for the erection of a lifeboat house and dwelling combined, at Bay View, N.S. Plans, etc., at the office of A. Johnston, Deputy-Minister, Department of Marine and Fisheries, Ottawa, and at post offices, Digby, Annapolis, Yarmouth, Weymouth, and Westport.

Ottawa, Ont.—Tenders will be received until April 22nd, 1912, for the construction of an 80-ft. single screw steel tug. Plans, etc., at the office of J. G. Sing, Esq., District Engineer, Confederation Life Bldg., Toronto; J. L. Michaud, Esq., District Engineer, Merchants' Bank Building, Montreal; G. G. Scovil, Esq., Superintendent of Dredges, St. John, N.B.; and G. M. Graham, Esq., Superintendent of Dredges, New Glasgow, N.S. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—The call for tenders for the construction of a wharf and for dredging basin at Sarnia, Ont., has been cancelled. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Sealed tenders for improving lower extreme to Lock No. 15, will be received until April 26th, 1912, addressed to L. K. Jones, Secretary Department of Railways and Canals, Ottawa. Plans, etc., at the office of the Chief Engineer of the Department of Railways and Canals, Ottawa, and at the office of the Resident Engineer of the Ontario-St. Lawrence Canals, Ottawa.

Ottawa, Ont.—Tenders for alterations to interior fittings, post office, Guelph, Ont., will be received at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa, until April 17th, 1912. Plans, etc., can be seen on application to Mr. R. McLeod, caretaker, public building, Guelph; Mr. T. A. Bastings, Clerk of Works, Postal Station F, Toronto; and at the Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until April 22nd, 1912, for interior fittings, Post Office and Customs, Essex, Ont. Plans, etc., with Mr. J. Laing, Clerk of Works, Essex; Mr. T. A. Hastings, Clerk of Works, Postal Station F, Toronto, and office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Penticton, B.C.—Tenders will be received until April 18th, 1912, for excavation, backfilling for, and making about seven miles of concrete pipe 18 inches diameter, including furnishing and hauling of materials; and hauling and laying of about two miles of 10-inch and 12-inch high pressure steel pipe, having partly flanged and partly ball and spigot joints. (See advt. in Canadian Engineer).

Regina, Sask.—Sealed tenders for electrical apparatus and supplies will be received by the City Commissioners, City of Regina, until noon of April 20th, 1912, for Sections 1 to 5, and until noon of May 15th, 1912, on Sections 6 to 9. (See advertisement in Canadian Engineer.)

Saskatoon, Sask.—Tenders will be received for all trades up to 20th April, 1912, for the erection of a residence and garage on Spadina Crescent for Chas. R. Hill, Esq. Plans and specifications at the office of Messrs. Thompson & Crockart, architects and civil engineers, Masonic Temple, Saskatoon.

Stratford, Ont.—Tenders will be received until April 15th, 1912, for mechanical filters, 8-ft. diameter by 20-ft. long, with all pipes, roses and fixtures. Full particulars may be obtained from W. H. Trethewey, Stratford, Ont.

Stratford, Ont.—Tenders will be received until April 22nd, 1912, for approximately 32,000 sq. yards of pavements. Specifications, etc., may be obtained on application to M. Ferguson, City Engineer. (See advt. in Canadian Engineer).

St. Norbet, Man.—Tenders will be received until April 23rd, 1912, for draining and grading of approximately 14 miles of road as follows:—8 miles on St. Mary's Road; 6 miles on Pembina Highway. All information may be had on application to the Municipal Engineer, D. R. Baribault, 607 Builders' Exchange Bldg., Winnipeg, Man. G. T. Landry, secretary-treasurer, for Ritchot, St. Norbert, Man.

Toronto, Ont.—Tenders will be received up to noon of Tuesday, April 23rd, 1912, for the construction of concrete abutments and concrete floors for the following bridges: Malton Bridge, North Woodbridge Bridge, and Cockburn's Bridge. Plans, etc., at the office of Frank Barber, Civil Engineer, 57 Adelaide Street E., Toronto. (See advt. in Canadian Engineer).

Toronto, Ont.—Tenders for the supply of one concrete batch mixer will be received by the Chairman, Board of Control, City Hall, Toronto, up to noon of April 17th, 1912. (See advertisement in Canadian Engineer).

Toronto, Ont.—Tenders will be received until April 23rd, 1912, for the construction of Sections Nos. 10 and 11, High Level Interceptor. G. R. Geary (Mayor), Chairman, Board of Control, City Hall, Toronto. (See advt. in Canadian Engineer).

Toronto, Ont.—Plans and specifications for large additions to the plant of the Goldie & McCulloch Co., Limited, Galt, Ont., are being prepared by T. Pringle & Son, Limited, Industrial Engineers, Continental Life Building, Toronto.

Toronto, Ont.—Tenders will be received by the Chairman, Board of Control, City Hall, up to noon of April 23rd, 1912, for the construction of Storm Overflow Sewer, Main Garrison Creek, Section No. 1. Specifications, etc., at the office of the City Engineer, Toronto. (See advt. in Canadian Engineer).

Vancouver, B.C.—Tenders will be received until May 2nd, 1912, for the following fire apparatus; One auto gasoline pumping engine; two auto hose wagons; one combination chemical engine and equipment for each car. Specifications may be seen at the office of Wm. McQueen, City Clerk, City Hall, Vancouver, B.C.

Winnipeg, Man.—Tenders are to be called at once for four miles of pavement by the Municipality of Assiniboia, Man. It will extend from the city limits, Portage Avenue to St. Charles. F. Ness, Clerk, Kirkfield Park, Winnipeg.

Winnipeg, Man.—Tenders for construction materials and supplies for the year 1912 will be received at the office of the Chairman of the Manitoba Government Telephone Commission, up to noon, April 22nd, 1912. Form of tender, specifications, etc., may be obtained from W. M. Houston, Supply Agent, McDermot & Charlotte Sts., Winnipeg.

Winnipeg, Man.—Tenders will be received up to noon of April 18th, 1912, for supply of labor and materials required for the erection of an electrical substation at Garson Quarries near Tyndall, Man. Plans, etc., at the office of the City Light and Power Department, 54 King St. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received by the Chairman, Board of Control, until April 16th, 1912, for supply of 1,250-⅞-inch diameter x 4-⅜-inch Tobin Bronze Bolts. Specifications, etc., at the office of the City Engineer, 223 James Avenue. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received up to noon of April 16th, 1912, for all trades except plumbing, heating and electric wiring required in the erection of a fireproof garage building on Henry Avenue, Winnipeg, for the Manitoba Government Telephone Commission. Plans, etc., at the office of the architect in the Telephone Building, at the corner of Charlotte St., and McDermont. F. C. Patterson, Chairman of Commission.

Winnipeg, Man.—Tenders for the erection and completion (except plumbing, heating and ventilation) of the new West End School Building, Yorkton, Sask., will be received by the Secretary-Treasurer of the Yorkton School Board, up to noon of April 22nd, 1912. Plans and specifications may be seen at the Winnipeg or Yorkton office of the Architect, J. Pender West, 607-9 Somerset Block, Winnipeg, and 9 Dunlop Block, Yorkton.

Winnipeg, Man.—Tenders for the supply of one or two electric trucks will be received at the offices of M. Peterson, Secretary, Board of Control Office, Winnipeg, Man., up to noon of April 17th, 1912.

CONTRACTS AWARDED.

British Columbia.—The B.C. Electric Railway Company has awarded a contract of 24 passenger cars to the St. Louis Car Company, of St. Louis. The cost of the new rolling stock with electrical equipment will be about $250,000.

Calgary, Alta.—The municipal council have awarded the following contracts for street paving:—

Curb and gutter, Crown Paving Company, 44c. per lineal foot.

Catch basin, Frank Fahrenbach and Company, $14.85.

Barrett Specification Roofs

Longest Wear for Lowest Cost.

THE cost per year of service is the only true test of a roofing.

It discloses the absolute superiority of Barrett Specification Roofs. That is why on large manufacturing plants, where costs are carefully computed, such roofs are almost invariably used.

Barrett Specification Roofs are inexpensive, costing much less than tin for instance, and little more than the best grade of ready roofings.

Their cost of maintenance is nothing, for these roofs require no painting; they can't rust and they will give satisfactory protection for 20 years or more.

Insurance underwriters classify Barrett Specification Roofs as "slow burning" construction acceptable on "fire-proof" buildings.

Barrett Specification Roofs are also immune from damage by acid fumes. That is why they are used extensively on railroad roundhouses.

On cotton mills, with their humid interiors, these roofs also give perfect satisfaction, for dampness does not affect them from below.

From the viewpoint of economy and satisfactory service, no other type of roof covering compares with Barrett Specification Roofs.

That is why they have won almost universal approval for use on flat-roofed structures of all kinds.

The Barrett Specification Roof illustrated above is 50,000 square feet in area and covers the Roundhouse of the Vandalia Lines (Penna. System) at Terre Haute, Ind.

The St. Louis Roofing Co., of St. Louis, Mo., were the Roofing Contractors.

Special Note.

We advise incorporating in plans the full wording of The Barrett Specification, in order to avoid any misunderstanding. If any abbreviated form is desired however the following is suggested:

ROOFING—Shall be a Barrett Specification Roof laid as directed in printed Specification, revised August 15, 1911, using the materials specified, and subject to the inspection requirement.

Copy of the Barrett Specification, with diagrams, ready for incorporation into building specifications, free on request.

Address our nearest office.

The Paterson Manufacturing Co., Limited

Montreal Toronto Winnipeg Vancouver St. John, N.B. Halifax, N.S.

McGibbon Bros., all sidewalks in ward one, west of the Elbow River, and north of the main line of the C.P.R., at 9¾c. per sq. foot, and all in ward two at 9⅞c. per sq. foot.

Frank Fahrenbach and Company, all sidewalks in ward three and ward one, east of the Elbow River, between the Bow River and the main line of the C.P.R. at 9c. per sq. foot. C. M. Payne, all sidewalks in ward four at 9c. per sq. foot.

Calgary, Alta.—The contract for the supply of one 2,500-k.w. steam turbine with Vickers generator for the city of Calgary municipal electric light and power plant has been awarded to Messrs. Laurie & Lamb, for $42,750, and for switchboards and apparatus, to Messrs. P. S. McLaren, Ltd., for $6,040.40.

Calgary, Alta.—The City Council have passed recommendations of the City Commissioners for the awards of the paving contracts as follows: A contract for 100,000 yards of bitulithic pavement will be awarded to the Canadian Mineral Rubber Company at $2.50 per yard; 100,000 yards of sheet asphalt to the Calgary Paving Company at $2.05 per yard; 70,000 yards of asphaltic concrete to the Crown Paving Company at $2.12 per yard; 50,000 yards of bitulithic to the Bitulithic and Contracting, Ltd., at $2.85 per yard, and 25,000 yards of granitoid to the Alberta Granitoid Company.

Galt, Ont.—The contract for the erection of the new Y.M.C.A. building has been awarded to the lowest tenderer, Mr. A. E. Faulkner, of Brantford, the price being $45,242.50.

Kingston, Ont.—Dormitory, R. M. C.; contractor, Michael Sullivan, of Kingston.

Montreal, Que.—John Millen & Son, Limited, of Montreal, have been awarded the contract for chain drives, aggregating 200-h.p., for the big addition to the Grand Trunk Pacific Grain Elevator at West Fort William, which is being erected by John S. Metcalfe & Co., the well-known Grain Elevator Engineers. The chain drive selected is the famous Coventry Noiseless.

Niagara Falls, Ont.—Nine bids were received for the construction work of the 75,000 sq. yards of pavement, but the tenders were not opened. Bids were returned and the matter was deferred for 60 days. W. J. Seymour, City Clerk.

North Bay, Ont.—Additions to Land Titles Office Building; Messrs. Robert Wallace & Son, contractors for building addition; the Cochrane Hardware, Ltd., for heating, plumbing and wiring.

North Toronto, Ont.—Mr. C. E. Lewis, of Toronto, has received the contract for the erection of a concrete bridge on Albertus Avenue, for which he will receive the sum of $1,923.

Ottawa, Ont.—Two 150 cu. yd. capacity steel hopper scows; the Brown Machine Co., Ltd., of New Glasgow, N.B.

Ottawa, Ont.—Mr. Geo. Ambridge has been awarded the contract for the building for the Dominion Wire Cloth and Manufacturing Company, to be erected in Mechanicsville.

Regina, Sask.—"Contract Number 1," for excavating the trench, laying concrete pipes, and backfilling Seventh Avenue from Albert Street to Toronto Street, was awarded to Wilson, Townsend and Saunders, of Moose Jaw, whose figure was $18,312.38. This company's tender was also accepted for similar work from Fourteenth Avenue out to the septic tank. Here the tender was for $17,538.94. The other tenderers in both cases were Robert J. Leckey and the Parsons Construction Company. Wilson, Townsend and Company were awarded a $24,893 contract for the construction of two filter beds, one stand-by tank and pipe lines. For blocks for false floors in the filter beds, the tender of Freeland Brothers, at $4,693, was accepted. The contract for the steel roof over the filter beds went to the Western Steel and Supply Company, at $8,400.

Saskatoon, Sask.—The new sedimentation basin for the municipality will soon be completed. It is to give settling facilities to 700,000 gallons of water additional to the present supply.

Saksatoon, Sask.—Labor on sanitary sewers and water construction; Prices were all unit prices; Contract divided into three sections as follows: Section 1 to Messrs. Flanagan & Murphy, Dauphin, Man. Section 2 to Messrs. Robinson & Foster, Spokane, Washington; Section 3 to Mr. A. R. Campbell, Saskatoon.

Saskatoon, Sask.—Labor on storm sewers; Saskatoon Construction & Engineering Co., 36-inch storm sewer.

Vancouver, B.C.—The City Council have awarded the contract for the construction of the big concrete Balaclava Street sewer main, which will form a trunk in the Greater Vancouver sewerage scheme, to Palmer Brothers & Henning, giving that firm the preference over Romano, Pinto & Co. The tenders submitted to the board of works were:—Palmer Brothers & Henning, $89,071; Romano, Pinto & Co., $89,105.90. The Graff Construction Company tendered at about $2 lower than Palmer Brothers & Henning. These three were much lower than the other half dozen contractors who also figured.

Vancouver, B.C.—The contract for concrete work in connection with the proposed new piers of the Great Northern Railway on Burrard Inlet has been awarded to Messrs. Cummings & Kiehel, of Seattle. It will involve the expenditure of $125,000. Messrs. H. Chase & Co., Seattle, have the contract for pile driving. The dredging contract has not yet been let. The entire improvement will cost over $400,000.

Victoria, B.C.—The municipal council of Oak Bay have awarded the contract for the construction of a trunk sewer to Messrs. Naylor Bros., of Huddersfield, England; their price being $119,260.75. The other tenders were:—Robert McLean & Company, $138,400; Hugh McDonald, $145,359.45; Victoria Machinery Company, $153,545.90; Jeffry & Burton, $156,076.25; Jas. McDonald & Company, $168,267.

Victoria, B.C.—The municipal council of Oak Bay have awarded the contract for a supply of water pipe to Messrs. Robert McLaren & Sons, of Glasgow, through the Messrs. Forsyth & Co., who represent this firm. Their figures were $28,701.21 (including $690.50) for specials. Other firms tendered as follows:—Messrs. Evans, Coleman & Evans, $28,861.60 (including $675.70 for specials); Victoria Machinery Company, $29,203.07; W. J. Winterburn, $31,271 (including $567 for specials); Canada Foundry Co., $31,423.50 (including $675 for specials); Robertson Godson Co., $36,867.95; Hutchison Bros., $784 for specials.

Winnipeg, Man.—The Carter Halls Aldinger Company have been awarded the contract for the erection of large garage for the Detroit Electric Automobile Co. The cost of this work is estimated at $50,000.

RAILWAYS—STEAM AND ELECTRIC.

Province of British Columbia.—The Canadian Northern Pacific Railway are planning to extend their lines toward the north. A report states that tenders for this work will be called within six weeks.

Humber River, Ont.—The new concrete pier of the Grand Trunk Railway bridge crossing this river withstood the severe test satisfactorily when the river ice broke up.

Niagara Falls, Ont.—A report states that the management of the Canadian Northern Railway are considering the construction of a railway bridge across the Niagara River in order to gain an entrance to New York State.

Winnipeg, Man.—Plans for the new Canadian Pacific Railway yards at Winnipeg, include new shops, round-houses and bridges across the Red River. Two thousand men are employed on construction.

LIGHT, HEAT AND POWER.

Province of British Columbia.—The C.P.R. is constructing a large dam on Bull River, near Cranbrook. Electrical power will be supplied to towns in the Crow's Nest as far east as Hosmer and west to Cranbrook, Moyie and Fort Steele. The company is also erecting a sawmill there.

Moose Jaw, Sask.—The municipal commissioners have received a large number of replies to their tender for the power house extension. It is reported that the proposition for an oil operated plant will not be considered to any great length.

Port Stanley, Ont.—The Hydro-Electric rates for this town have been fixed as follows:—4c. per square foot and 5c. per kilowatt for actual current used; 12c. per kilowatt for the first 30 hours, and 5c. for time additional as a commercial current consumption basis. These rates are about 25 per cent. less than the charges on the former system.

Tyndall, Man.—The Municipal Light and Power Department of Winnipeg, Man., are about to erect a substation at Carson Quarries near Tyndall. M. Peterson, Secretary,

48 in. CONTINUOUS STAVE LINE.

Manufacturer of
Galvanized Wire Machine Banded
WOOD STAVE PIPE
CONTINUOUS STAVE PIPE
RESERVOIR TANKS

For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

Full particulars and estimates furnished.

PACIFIC COAST PIPE COMPANY, LTD.
Factory: 1551 Granville Street, VANCOUVER, B.C. P.O. Box 563.

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EASILY MOVED FROM JOB TO JOB

Test after test has proved that they mean

Low cost of maintenance, along with capacity, strength, and durability.

Demonstrations daily, in all our branches and warerooms.

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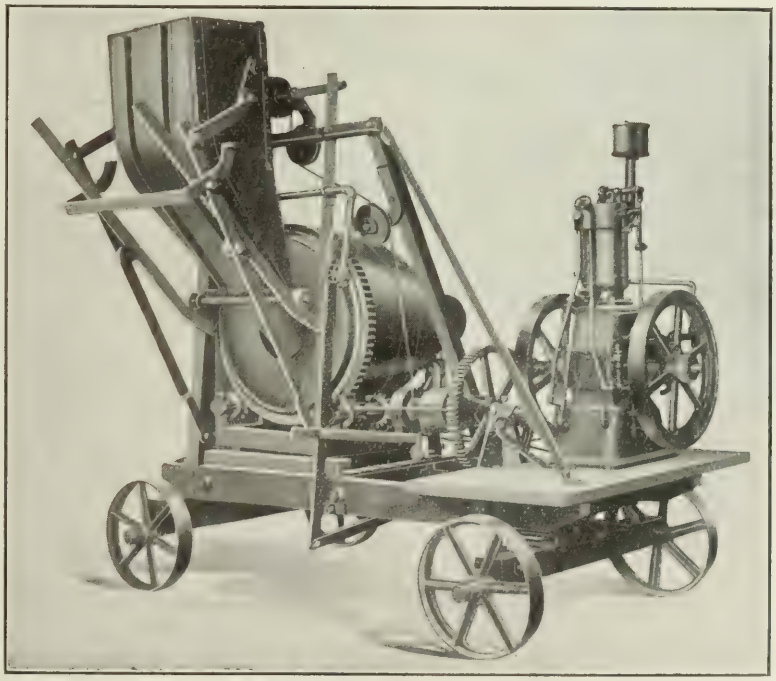

Semi-steel castings used throughout entire construction.

New automatic power dumping and new loading device, means one man operates entire machine, which gives you greater capacity, with reduced labor.

St. John, N.B.:
A. R. Williams Machy. Co.
15 DOCK ST.

Sales Manager for Quebec,
G. O. McDONNELL,
2059 Mance St.,
MONTREAL, QUE.

Head Office and Warerooms:
WETTLAUFER BROS. 178 Spadina Avenue, TORONTO, ONT.

Board of Control, will receive tenders for the erection of the building until April 18th next.

Vancouver, B.C.—The estimates of city electrician Woodroofe for new lighting standards totals $235,000. The court of revision will report on the matter.

GARBAGE, SEWAGE AND WATER.

Edmonton, Alta.—The commission reporting on a water supply have made the following recommendations:—That an additional 6,000,000 gallon low lift pump, and an additional 6,000,000 gallon service pump be installed. Installation of gauges to determine run off and rain fall at Pigeon Lake. Take water from two sources only, Saskatchewan River and Pigeon Lake. That a further investigation be taken up.

Galt, Ont.—The municipal water board are preparing to install a synchronous motor in the pumping plant. The machine will operate on the mains of the hydro-electric commission. Specifications are prepared for a one-and-a-half million gallon pump for the above. Mr. E. O. Fuce is the town engineer.

Regina, Sask.—The municipality will sink three wells with a view of increasing the water supply.

Weston, Ont.—The ratepayers will vote and decide whether they will expend the sum of $40,000 on a new sewerage system. The system will be a trunk line emptying into a filtration plant near the Humber River.

BUILDINGS AND INDUSTRIAL WORKS.

Province of Alberta.—The Canadian Pacific Railway are preparing to proceed with considerable concrete work in connection with the irrigation scheme in this province. Mr. A. S. Dawson, chief engineer at Calgary, is in possession of the details.

Brantford, Ont.—A report states that the American Radiator Company will erect an important addition to their plant. The extension will be about 750 feet in length.

Province of British Columbia.—Mr. George Collins, of the Seal Cove Fish and Cold Storage Company at Prince Rupert has announced the rough details of a new cannery near Prince Rupert. It will cost about $300,000.

Fort William, Ont.—The Northern Navigation Company will construct a new steamer. The work will be done in the yards of the Western Drydock Company, who have secured the contract. It will be 425 feet long, 55 feet beam, and cost about $750,000.

Fort William, Ont. — The management of the Western Drydock Company will enlarge their present plant by the addition of two buildings. A new machine shop 270 by 100 and a blacksmith shop of smaller dimensions are included in the plans.

Granby Bay, B.C.—The management of the Granby Consolidated Mining and Smelting Company are considering the details of a new plant to cost $1,000,000. It is reported that the new work will start in May. Mr. F. M. Sylvester is the general manager of this company and the head office is at Trail, B.C.

Guelph, Ont.—A report states that the Guelph Carpet Mills will erect a new warehouse. It will be three storeys 60 by 60. Messrs. Tanner, T. Colwill & Tanner are the architects for the new structure.

Lethbridge, Alta.—The Board of Trade have announced that a large hotel will be erected in this city. The cost will be about $300,000. Messrs Paul Fader and J. F. Davis of Calgary, are interested in the project.

Montreal, P.Q.—A ten-story office structure will be erected on the corner of Notre Dame and St. Peter Streets. Mr. John Findlay is interested in the matter.

Niagara Falls, Ont.—The management of the Sanitary Can Company are planning to construct extensive additions to their present plant. The work includes considerable concrete and steel work.

Owen Sound, Ont.—This municipality will construct a new school at an estimated cost of $35,000.

Ottawa, Ont.—Mr. C. J. Booth will erect a seven story office building in this city. Work will start on the structure about the first of May next. Mr. Albert Ewart, has prepared the plans.

Port Stanley, Ont.—The members of the congregation of Christ Church are considering the erection of a new rectory. Messrs. Thomas Meek, M. Hyndman and H. Ellison comprise the committee that will report on the matter.

Port Colborne, Ont.—The Buffalo Union Furnace Company of New York, will erect a plant at this place for the manufacture of pig-iron.

Quebec, P.Q.—The Government will call tenders at an early date for the construction of a graving dock in this city. The tenders are to be in the hands of the proper officials by May 20th.

Quebec, P.Q. — The Federal Government have called tenders for the construction of the new drydocks at this point. Tenders close on July 2nd next. The successful bidder will receive 3½ per cent. subsidy for thirty-five years on $5,000,000. The dimensions of the drydocks will be 1,150 feet long, 137 feet wide, and 37 feet deep.

Regina, Sask.—A company has been formed to drill for natural gas, and will be known as the Western Gas & Oil Company. Mr. G. F. Baxter, of Pense, Sask., is the president of the new company. They will be equipped for a depth of 2,000 feet at present, and will increase this should occasion demand.

Regina, Sask.—The management of the Cockshutt Plow Company have let the contract for the erection of a new factory in this city. It will consist of three stories and a basement constructed on the property owned by the company in Block 77 with a frontage of 150 feet on Broad Street, and 100 feet on Fifth Avenue. The plans include two large-sized heavy capacity freight elevators. The total cost is estimated in the neighborhood of $120,000.

Saskatoon, Sask.—The work of enlarging the Empire Hotel has been commenced. Mr. Herbert Lancaster is in charge of the work and Mr. Sutton is interested in the business of the hotel. The work will add forty-four additional rooms to the building.

Saskatoon, Sask.—Mr. J. C. Drinkle will erect two large stores and office buildings in this city during the next few months.

Saskatoon, Sask. — Messrs. Thompson, Daniel & Colthurst are preparing plans for the construction of a new hotel for this city. The materials of construction will be concrete and brick with stone dressing. The building will be 100 by 130 and cost about $150,000. Mr. James Barry is the proprietor.

Stanley Springs, Ont.—The plant of the Western Brewing Company at this point will be enlarged by an addition to cost about $500,000. The head offices of this concern are in Winnipeg, Man.

St. Catharines, Ont.—The Canadian Bank of Commerce will erect a suitable branch office in this city during the coming summer.

St. John, N.B.—Messrs. Ames-Holden-McCready Co., Ltd., are about to erect a large warehouse in this city. It is to be of brick, five stories in height, 31-ft. x 100-ft.

Toronto, Ont.—The management of the Canadian Northern Railway announce their intention of erecting a ten-story office building on the site of the present offices of the company, Toronto and King Streets.

Vancouver, B.C.—Mr. A. A. Davidson is erecting an apartment house in this city at a cost of $150,000.

Vancouver, B.C.—A report states that the Dominion Government will erect a large terminal elevator at Burrard Inlet during the next year.

Victoria, B.C.—Mrs. S. J. Curry and Rev. T. E. Holling are interested in a project for the erection of a new church.

Victoria, B.C.—The Provincial Government have prepared plans and are about to call for tenders for the erection of a new court house, lock-up, and constables' quarters, at Arrowhead, and constables' quarters at Yale, B.C.

Welland, Ont.—The management of the Welland Machine and Foundry Company will erect a new foundry, a paint shop and storehouse and will install one or more travelling cranes.

THE TRIPLEX BLOCK

A Triplex Block hung from a temporary rigging and used for laying pipe.

What is the Life of a Triplex Block?

WE don't know. Triplex Blocks built by the Yale and Towne Co. at the very beginning—twenty-five years ago—are still in actual use. The Triplex Block of to-day possesses greater lasting powers. With its steel parts—its chain superior to any other—its non-wearing gear movement—and the guarantee of a rigorous test before shipment under a fifty per cent. overload. It will outlast the man who buys it, no matter how young he may be.

The Canadian Fairbanks-Morse Company

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Fairbanks Standard Scales — Fairbanks-Morse Gas Engines
Safes and Vaults

MONTREAL ST. JOHN OTTAWA TORONTO WINNIPEG
CALGARY SASKATOON VANCOUVER VICTORIA

Winnipeg, Man.—The Detroit Electric Automobile Company will erect a fine garage for their cars in this city. Solid reinforced concrete will be used throughout, and the 60-foot front will be particularly handsome. It is designed to be the most thoroughly fireproof building in Winnipeg.

BRIDGES, ROADS AND PAVEMENTS.

Alton, Ont.—A large steel bridge near this town was badly damaged by the recent floods. The bridge was three years old.

Calgary, Alta.—The commissioners have recommended to the council that the following tenders for street paving be accepted: 70,000 yds. asphaltic concrete to the Crown Paving Company at $2.12, and when required by the engineer to coat same with squeegee at the price of 10c. extra; 100,000 yards sheet asphalt to the Calgary Paving Company at $2.05; 100,000 yards to the Canadian Mineral Rubber Company at $2.50; 50,000 yards of bitulithic pavement to the Bitulithic Contracting Company at $2.85; 25,000 granitoid to the Alberta Granitoid Company at $2.65.

Calgary, Alta.—The municipal commissioners have recommended that the following tenders for street paving be accepted:—70,000 yards asphaltic concrete, Crown Paving Company, $2.12, with squeegee coat, 10c. yard extra, $2.22; 100,000 yards street asphalt, Calgary Paving Company, $2.05; 100,000 yards Canadian mineral rubber, $2.50; 50,000 yards bitulithic, Bitulithic Paving Company, $2.85; 25,000 yards granitoid, Alberta Granitoid Company, $2.65. This covers work on last year's tender and work on Ninth Avenue East, from Twelfth Street East and Second Street East, from Eighteenth Avenue to Victoria Bridge.

County of Essex, Ont.—A movement calling for the construction of a memorial driveway along the river front has been started. Mr. Charles Montreuil, warden of this county, was elected president of the association discussing the project.

Ottawa, Ont.—The Ottawa Improvement Commission will construct a driveway at a cost of $10,000, and will convert an old cemetery into a park at a cost of $14,700.

Province of Saskatchewan.—The provincial government of this province have appointed a board for the purpose of administrating the affairs of the provincial highways, etc. A method will be worked out whereby the municipal authorities will aid the provincial officers in this work. Mr. A. J. McPherson, Regina, will, in all probability, be the chairman of the new board.

Toronto, Ont.—The City Engineer has recommended that the following pavements be proceeded with:—

Pelham Street, block pavement	$9,795
Dufferin Street, block pavement	11,022
Sherbourne Street, asphalt surface	14,484
Wyndham Street, bitulithic	4,604
Crescent Road, Roc-mac (reconstruction)	10,368

Vancouver, B.C.—Paving recommendations as local improvements, calling for a total expenditure of $532,652, of which the city's share would be $136,696, have been submitted by the City Engineer to the Board of Works..

County of York, Ont.—The pavement of the Lake Shore Road from the Humber River to Mimico will be of Dolarway and not of tar macadam as previously announced. Messrs. J. H. McKnight Construction Company, Ltd., will do the paving. The offices of this company are at 152 Bay Street, Toronto.

FIRES.

Deseronto, Ont.—The plant of the Standard Iron Company was damaged by fire to the extent of $50,000.

Hamilton, Ont.—The Hamilton Facing Mills were damaged by fire to the extent of $10,000.

New Toronto, Ont.—The Brown Copper & Brass Rolling Mills were destroyed by fire on Sunday, April 7th. The loss is estimated at $125,000.

Vancouver, B.C.—Fire damaged the Foster building on Hastings Street to the extent of $232,000. This sum includes the damage to the contents, which was distributed among retail stores occupying the lower portions of the building.

CURRENT NEWS.

Brantford, Ont.—During the ravages of the overflowing of the river, a large gas main was carried away which necessitated the shutting off of the gas throughout the city.

Calgary, Alta.—The management of the Builders' Exchange have been instructed by the members to request the Canadian Northern and the Grand Trunk Pacific Railways to give all contracting work to the local contractors when those roads enter the city of Calgary. They claim that as they do considerable freighting outside contractors should be excluded from railway work in this vicinity.

Collingwood, Ont.—The Collingwood Shipbuilding Company will construct a canal and lake steamer for Keystone Transportation Company at Montreal. The new vessel will be employed in the grain and coal carrying trade between Lake Erie and Montreal. It will be 258 feet long by 42.6 feet beam, 20 feet depth, 800 horse-power engines, and have a speed of ten miles an hour. The capacity will be 2,400 short tons, or 80,000 bushels of wheat, and the cost will be approximately $140,000.

Fort William, Ont.—Arrangements are under way for the installation of a fire alarm system in this city. The citizens voted in favor of spending $12,000 on fire alarms, and tenders will be received at the city hall up to April 15th.

Niagara Peninsula, Ont.—The Dominion Government will call tenders for the construction of the new Welland Canal at an early date.

Toronto, Ont.—The Dominion Government have made a grant of $218,517 for improvements to the harbor of this city.

PATENTS.

The following is a list of patents recently issued from the Canadian Patent Offices in Ottawa. This list is furnished by Messrs. Featherstonhaugh & Company, Royal Bank Building, Toronto:—

A. Hough, explosives; N. E. Lister, flangers for railways; W. McCloskey, mop wringers; H. E. Niblett, building blocks; J. J. Carrigan, wagon brakes; C. R. Cote, electric medical apparatus; M. L. Dansereau, weak measures and distributers; J. D. Hoffman, machines for making cement shingles and the like from plastic materials; C. J. Hickling, starters for explosive engines; J. L. Marcil, street indicators; G. Maude, cattle stanchions; A. A. Mowry, set works for sawmill carriages; M. M. Passy, cream removers for milk bottles; A. Perrault, egg whips; A. H. Reid, concrete; H. C. Shipman, games; A. C. Thompson, fitting spring for mattresses and the like; L. A. Whyte, containers.

The following is a list of patents recently issued through the agency of Messrs. Ridout & Maybee, Manning Chambers, Toronto, from whom further particulars may be obtained:

Canada:—Nathaniel & Gideon Beam, thresher; Charles Maples, cloches for French garden culture; J. C. Doust, clothes-line reel.

United States:—W. F. Scott, reinforced concrete; A. Nonnington & H. G. Ackers, production of calcium of cyanamide; The Massey-Harris Company, Limited, lever mechanism.

The following is a list of patents recently issued through the patent office of Herbert J. S. Denison, Star Building, 18 King Street, West, Toronto, from whom further particulars may be obtained.

C. J. Bothwell, adding machines; Jas. Payer, hat fastener; J. C. Royce, separable electrical connection; H. B. Croker, printing presses; C. L. Williams, sleeper or ground for walls; W. N. Nicholls and A. W. Carmichael, cleat for roofing; M. J. Haney, concrete block structures; A. Roebuck, snow plow; H. C. Hogarth, filter; J. H. K. McCollum, internal combustion engine; H. R. Winter, necktie; T. G. McGonigle, rotary engine; J. D. Hoffman, cement shingle machine; S. F. Leslie, coupling device; Geo. Maude, cattle stanchion; B. F. Johnston, gang plow; F. W. Lanchester, high speed reciprocating engines; M. J. Haney, package handling appliance; Geo. Borgfeldt & Co., sheaf of wheat.

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TRADE INQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commission for Canada, 17 Victoria Street, London, S.W., during the week ending March 25th, 1912:—

A Birmingham firm manufacturing plate and wire springs and similar steel goods, school and machinery accessories, etc., including all kinds of small bent plate and wire goods, twists, bows, etc., to pattern or drawing, are desirous of introducing their goods to the Canadian market.

A correspondent in South Wales has a market for white oak staves, and would like to hear from Canadian exporters.

A correspondent at Frankfort-on-Main reports a large market in Germany for Canadian corundum, and would like to hear from miners and exporters in the Dominion.

A Scottish firm of rubber tyre manufacturers make inquiry for the names of Canadian manufacturers of rubber.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:—

A firm of importers in Genoa, Italy, invite offers from Canadian shippers of lard, tallow, greases and soap fats generally. They would also like to hear from producers of dried codfish and provisions.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16177—March 25—Approving location of G.T.R. station to be erected at Houston, Coast District, B.C.

16178—March 25—Approving location of Kettle Valley Ry. from mileage 43.92 to 55, northwest of Midway, B.C.

16179—March 26—Approving location of three G.T.P. Stations situated in Coast District. B.C. (No name).

16180—March 28—Directing C.N.R. to put its main line running tracks in Saskatoon yard in good shape and condition before June 1st, 1912, pending completion of work train not to exceed six miles per hour.

16181—March 28—Authorizing Lachine Jacques-Cartier & Maisonneuve (G.T.R.) Railway Co. to cross certain streets in Montreal, Que., by overhead crossings, subways and level crossings.

16182—March 25—Rescinding Order 16122 of March 14th, 1912, and slightly amending Order 16095 March 7th, 1912, re C.N.R. Taking Lands town of Trenton, Ont.

16183—March 28—Rescinding Order 13060 of February 21st, 1911; and approving by-law of M.C.R. authorizing C. F. Daly, V.P., L. W. Landman, G.P.A., W. C. Rowley, G.F.A., and J. L. O'Brien, Chief of Tariff Bureau, to prepare and issue tariffs of tolls, etc.

16184—March 4—Rescinding Order 15938 of Febuary 6th, 1912, in so far as it authorizes construction of railway across Rachel Street, Lachine, Jacques-Cartier & Maissoneuve Ry.

16185—March 26—Directing G.T.R. to within 90 days from date of this Order install electric bell at crossing just east of Clarkson Station, Ont., 20 per cent. from Railway Grade Crossing Fund.

16186—March 26—Authorizing Province of Saskatchewan to construct highway across C.N.R. in S.W. ¼ Section 30, Twp. 47, R. 26, W. 2 M.

16187—March 27—Relieving C.P.R. from further protection at 1st highway south of St. Vincent Rd. mileage 91, near town of Owen Sound, Ontario.

16188—March 28—16189—March 26—Authorizing C.P.R. to construct three spurs from main line in S.W. ¼ of Section 28, Twp. 23, R. 29, W. 4 M., into and through Blocks Nos. 24, 25, and 30, and Block B. in subdivision of S.E. ¼ of Section 28, Twp. 23, R. 29, W. 4 M. And spur for the Calgary Brewing and Malting Co., at Coleman, Alberta.

16190—March 28—Rescinding Order 15683 of December 23rd, 1911, and recommending to the Governor-in-Council for approval rules of regulations of G.T.R. operating department.

16191—March 27—Authorizing G.T.P.B.L.Co. to cross with its Regina-Moose Jaw Branch the Moose Jaw Northwest Branch of the C.P.R. by undergrade crossing at Moose Jaw, Sask.

CAISSON SICKNESS.

A French authority has recently made public a report on his investigations into the above disease and has come to the conclusion that the distressing effects of the malady are due to the fact that when air is compressed the oxygen factor is reduced to four-fifths of the proportions that it held before compression.

BOOK ANNOUNCEMENT.

The series of articles which have been running in The Canadian Engineer entitled

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Volume 22. Toronto, April 18, 1912

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The Canadian Engineer

An Engineering Weekly

THE RED RIVER BRIDGE FOR THE NATIONAL TRANSCONTINENTAL RAILWAY

By D. C. TENNANT.

The double track bridge over the Red River for the National Transcontinental Railway, has presented, both in design and construction, many very interesting problems. To such an extent is this true, that there will be room in this paper for only a general description of the more important features. The whole bridge, with its approach spans, comprises a length of almost half a mile. The bridge over Water Street, Winnipeg, shown at the left-hand side of plate No. 1, is the most westerly work of the Transcontinental Commission. Beyond this point the line is being constructed by the Winnipeg Terminal Co., for the Grand Trunk Pacific and Canadian Northern Railways.

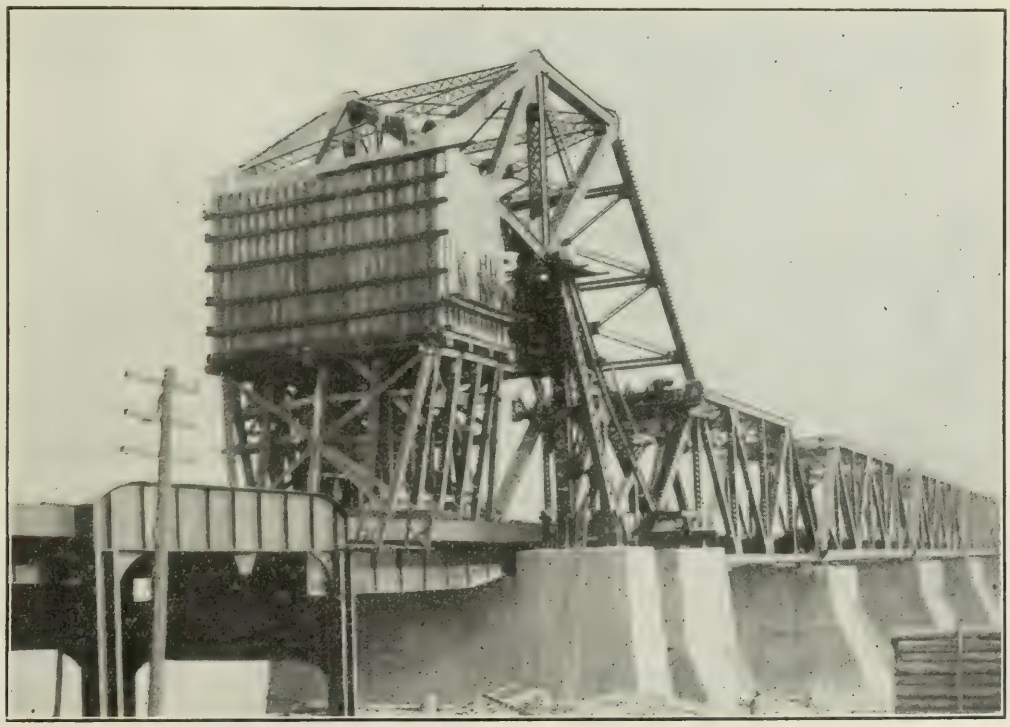


Fig. 1.—View Taken from the South Side Looking East.

Coming from the east, on the St. Boniface side of the river, the double track road is carried on an earth embankment with side slopes of one and one-half horizontal to one vertical, and the first span is a deck plate girder with solid floor, spanning a 67 ft. 2 in. clear opening at Taché Avenue. After another short stretch of earth embankment the road is carried over two spur tracks of the Canadian Northern Railway by a 58 ft. through plate girder span with floor beams, stringers, and wooden ties. This brings us to the main bridge over the Red River itself, and first we have four 150 ft. 0 in. C. to C. double track through truss spans, the most easterly one having one end supported on the same pier that carries the end of the girder span already mentioned, and the others resting on piers 1, 2, 3 and 4, which are carried down to rock in the bed of the river. Red River is navigable at this point for fairly large steamers, and a clear waterway of about 110 ft. width was required. As the bridge was at no great height above the water it became necessary to provide a span of some movable type. The deepest channel being near the Winnipeg shore where economy of space is ever becoming a more important consideration, it was decided to use a Strauss Trunnion Bascule span. The moving leaf—129 ft. 6 in. long C. to C.—is towards the east, the toe resting when the span is closed on pier No. 4, which also carries the end of one of the one hundred and fifty foot fixed spans. The counterweight tower is forty feet long C. to C., spanning between piers Nos. 5 and 6. Westward from this there is a viaduct crossing over two tracks of the Winnipeg Transfer Co., a spur railroad track, Mill Street, and a lane. As these are all

crossed on the skew, and as the line of the Transcontinental commences to curve to the south at a short distance beyond the Bascule span, it will be readily understood that the actual size of this viaduct, though not inconsiderable, gives a most inadequate idea of the amount of work in the design and manufacture. The curve continues to the west and south, the tracks being carried on an earth embankment with vertical retaining walls of concrete. The embankment is pierced at four points: first by Thistle Lane and a spur track, next by another spur track and then at Notre Dame Street and at Water Street, the opening at Notre Dame Street being 66 ft. 0 in. clear, and that at Water Street 60 ft. 4 in. clear. In general, the floors of the viaduct and of the isolated spans forming this western approach are similar to that of the Taché Avenue bridge, consisting of four deck plate girders, two under each track, carrying a concrete floor and ballast. The concrete floor is supported on I beams running across the tops of the deck girders and cantilevering out on each side supporting longitudinal facia girders. In the viaduct, and at Notre Dame and Water Streets, the main girders are carried on posts and heavy cross floor beams. Where the tracks cross under the viaduct, through plate girders were used instead of deck girders, to give the necessary headroom. At the two small openings in the embankment, for Thistle Lane and the two spur tracks, the solid floor was not necessary. A through girder span with four stringers under each track was used at Thistle Lane, and at the other opening the stringers rest directly on the retaining walls, without floor beams or side girders. As shown on Plate No. 1, the main bridge, with its long curved tail of a western approach spotted here and there with small bridges, resembles a huge rocket fired from Fort Garry station, which is only a fraction of a mile farther west.

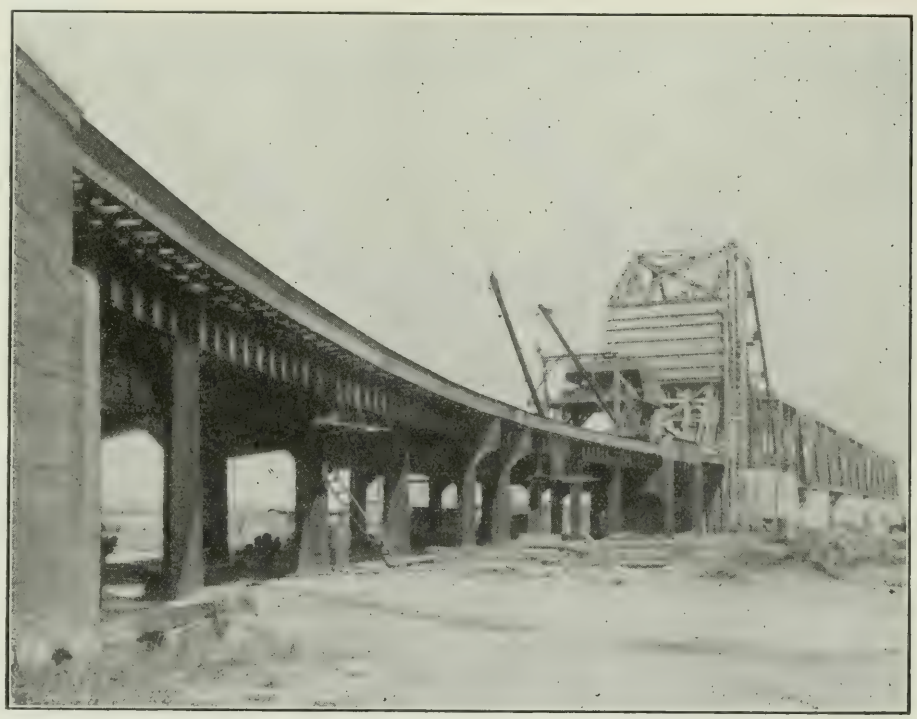


Fig. 2.—View Showing Viaduct and Erection Traveller.

The general design of substructure and superstructure was made in the Bridge Department of the Transcontinental Railway. The designing of the details of the whole of the steel work was made by the Dominion Bridge Company, of Montreal, the Strauss Bascule Bridge Company, of Chicago, furnishing the drawings and details of the Bascule span, from which the shop drawings were prepared. All detail shop drawings were made by The Dominion Bridge Co., and the steel work was manufactured by them at the Lachine shop and erected by their own erection department. The contractors for the substructure, including piers, pedestals, retaining walls, etc., were Messrs. Haney, Quinlan and Robertson, Toronto. The entire structure was completed at the end of the year 1911.

The river piers, numbered from 1 to 6 on Plate No. 1, are of concrete construction and of the dimensions shown in the plate. It has been stated that this is the only bridge in the vicinity in which the foundations rest on solid rock. The abutments and retaining walls on land are not carried down to bed rock, but rest on piles driven into the superstratum, which is a thick clay. The drawings of all concrete foundations were prepared by the National Transcontinental Railway.

The steel work was designed in accordance with the general specifications for steel superstructures of the Department of Railways and Canals, of 1908. The assumed live load was the two standard locomotives followed by the uniform train load, belonging to class "Heavy" of the specification, or a load of 120,000 lbs. on two axles 7 feet apart, whichever gave the greater stress. This live load is given in detail on Plate No. 1, and is the live load for which all Transcontinental Railway bridges are designed. To provide for impact the resultant from the dead and live load stresses is increased by the quotient of the square of the live load stress divided by the sum of the dead and live load stresses. In spans under 80 ft. in length a further allowance is made for impact by multiplying the live load by the factor $(1.40 - \frac{L}{200})$ in which L = the length of the loaded distance in feet, which produces the maximum stress. The permissible unit stress in tension on medium steel was taken at 16,000 lbs. per square inch. The allowable stress for compression was:

$$\frac{16{,}000}{1 + \left(\frac{L^2}{9{,}000\ R^2}\right)}$$

L and R both being in inches.

but in no case was the stress in compression allowed to exceed 13,000 lbs. per square inch. In the Bascule span the maximum allowable stress in either tension or compression with the bridge moving was 13,000 lbs. per sq. inch. The permissible stresses in shop rivets were for shear 10,000 lbs. per square inch, and for bearing 20,000 lbs. per square inch. All field rivets being driven by power, the number was increased ten per cent. over the number necessary for shop rivets. All rivets throughout the work were made ⅞ inch diameter.

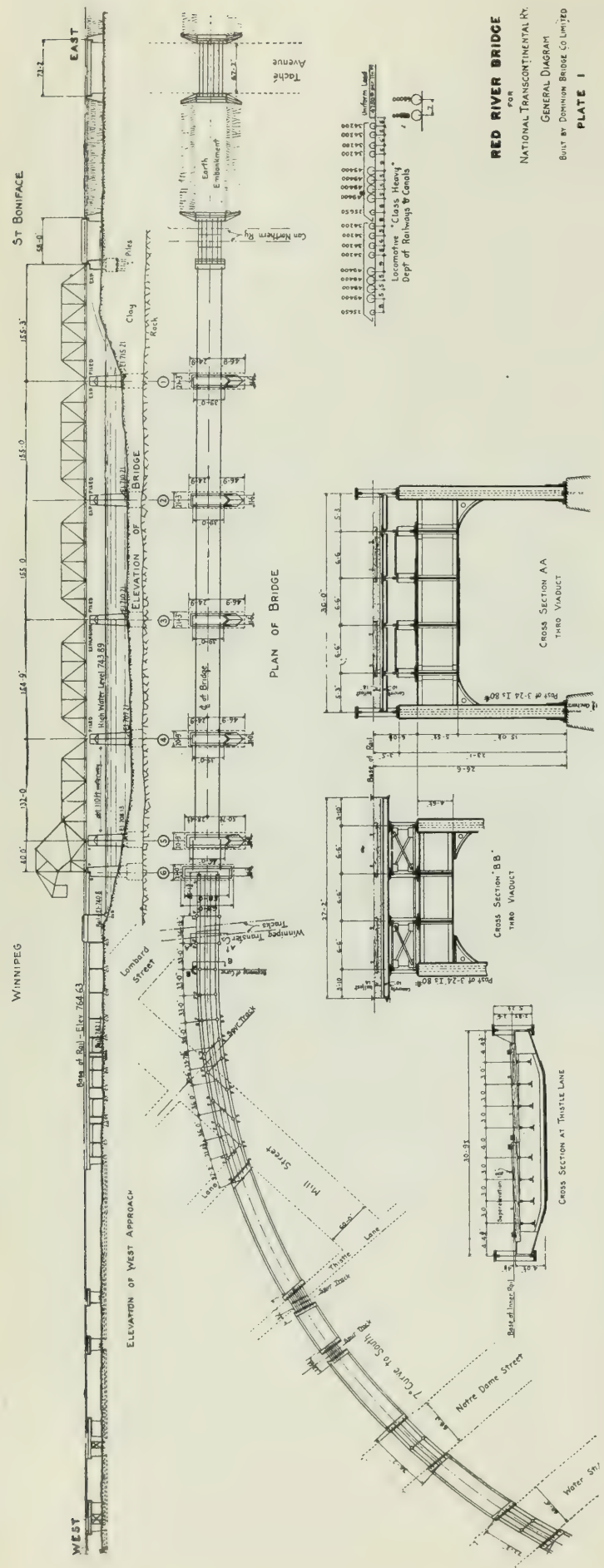
The deck span over Taché Avenue has a cross section similar to that shown on section B.B. on Plate No. 1. The cross beams carrying the concrete floor are 9 in. I's at 21 lbs. spaced 18 in. centre to centre. These rest on the top flanges

of the four main girders and cantilever out to the sides supporting facia girders 27 ft. 2 in. apart. The facia girders consist each of a 30 x 5/16 in. web with two 3 x 3 x 5/16 in. angles forming the top flange, and one 3 x 3 x 5/16 in. angle at the bottom. The top flange of the facia girders is set 4 inches above the base of the rail. The 9-in. cross beams support a concrete slab 10 in. thick, the top of which is 2¼ in. above the top of the beams. This concrete slab supports 14 inches of ballast, the top of the ballast being level with the base of rail, so that the top of the 9-in. beams is 16¼ in. below the base rail, or 20¼ in. below the top of the facia girders. The beams are connected to the facia girders with web connections and the girders are stiffened with vertical gussets from the top of every fourth cross beam. At the abutment there is an apron plate spanning from the last cross beam to the top of the ballast wall. The four main girders span the whole width of the street without posts, making a length centre to centre of end bearings of 71 ft. 0 in. They each have a 72 x 7/16 in. web plate and top and bottom flanges of two 8 x 8 x ¾ in angles, two 18 x 11/16 in. cover plates, and one 18 x ⅝ in. cover plate. These four girders are spaced traversely, making three equal spans of 6 ft. 6 in. centre to centre. There are no top laterals, as the concrete floor forms a most effectual bracing. The two girders under each track have a bottom lateral system, and all four girders are connected together with brace frames, spaced about twelve feet apart longitudinally. The pier members are of the Standard Transcontinental type, consisting of a heavy cast iron bed plate with a turned spherical disc surface on top, and a thick shoe on the girder dished on the under side to suit the disc, the shoe plate and casting together making a height of about 1 ft. 4 in.

In the 58-ft. through span over the spur tracks of the Canadian Northern Railway, the standard open floor of the Transcontinental was used with 8 x 10 in. ties notched ½ in. over the stringers, and laid in two lengths of 13 ft. 6 in. butting in the centre of the bridge, making the outer ends 7 feet from the centre line of the track. It was necessary to have 22 ft. 6 in. clearance from the base of rail of the spur tracks to the under side of the bridge, but only for a width of 7 feet over each track. It was, therefore, possible, by arranging the floor-beams to come between the tracks of the Canadian Northern, to allow their bottom flanges to be about 2 feet lower than the bottom of the stringers and main girders. The side girders are 31 feet apart and the bending moment on the floor beams consequently large, so that the extra depth thus obtained for them was most desirable. The cross section of this span is typically the same as that shown for Thistle Lane on Plate No. 1, but the outer rail has no superelevation as at Thistle Lane, and there are but two lines of stringers under each track instead of four. This span is divided by the two floor beams into three panels. The stringers—two under each rail—are built gidders, 30¼ in. deep. The floor beams have 60 x ⅜ in. webs and a flange composed of two 8 x 8 x ¾ in. angles, one 17 x 11/16 in. plate and one 17 x ⅝ in. plate. The bottom flange is curved up at the ends to meet the bottom of the main girders. The girders are 8 ft. deep, 3 ft. 3 in. below the rail and 4 ft. 9 in. above, and consist each of a 96 x ⅜ in. web and flanges of two 8 x 8 x ¾ in. angles, one 17 x ⅝ in. cover plate and two 17 x ½ in. cover plates.

Fig. 3.—Curved Western Approach, Looking From the East.

The material and general dimensions of the four 150-ft. through truss spans over the river are indicated on Plate No. 2, and Photo No. 1 gives an idea of the appearance of the completed bridge. The spans have 6 panels of 25 ft. each and are 32 ft. 0 in. deep, centre to centre of chords and 31 ft. 3 in. wide centre to centre of trusses. The main diagonals in the two centre panels were reversed from the customary direction, making them compression members when there is a symmetrical arrangement of the live load. This adds to the appearance of the truss, and it was also found to be economical on account of the reversal of stress in these members. The trusses are cambered 1⅜ in. at the centre. Longitudinal tractive force is provided for in the second and fifth panels of the bottom laterals, as shown on Plate No. 2, by the addition of some sub-laterals forming a triangular truss, the chords of which are the main laterals and the bottom flange of the floor beams, while the additional laterals and the bottom flanges of the stringers form the web members. There is no separate lateral system for the stringers, but at the centre of each panel there is a continuous line of brace frames, between the four stringers, and the centre brace frame is connected at the bottom to the intersection of the main bottom laterals. The bottom flanges of the stringers are also connected to the main laterals wherever they cross them. The portal strut and the intermediate sway struts at each truss vertical are tied to each other at their centre points and to the intersections of the main top laterals, by a continuous strut on the centre line of the bridge, of the same depth as the top chord and the intermediate struts. The intermediate struts are knee-braced to the truss verticals at each panel point. The details of the portal were arranged so that it could be set in place all riveted up without spreading the trusses. All abutting joints in the top chord were faced to bear. These top chord joints and all other joints and splices were riveted sufficiently to develop the full strength of the material. The bottom chord joints were also faced as a matter of good workmanship. The end gusset plates on the bottom chord were protected on their tops and at the ends from the weather, by a cover plate bent to conform to the profile of the gussets and bolted to connection angles on the gussets with ⅞ in. machine bolts, so that the bent covers could be removed whenever it was decided to inspect or paint the shoe diaphragms. The end reaction of 1,134,000 lbs. is taken care of by a shoe of cast steel 3½ in. thick riveted to the underside of the bottom chord, dished on the underside to a concave sperical surface of 3 feet radius to engage a lower convex casting 5 in. thick which in turn rests on three 2¼ in. plates riveted together, resting on a nest of eight 6 in. rollers, 4 ft. 3 in. long. This roller nest rests on a 2 in. plate, 4 ft. 11 in. by 5 ft. 0 in. The plate sits on the masonry with ⅜ in. sheet lead between to take up inequalities in the bridge seat. On the



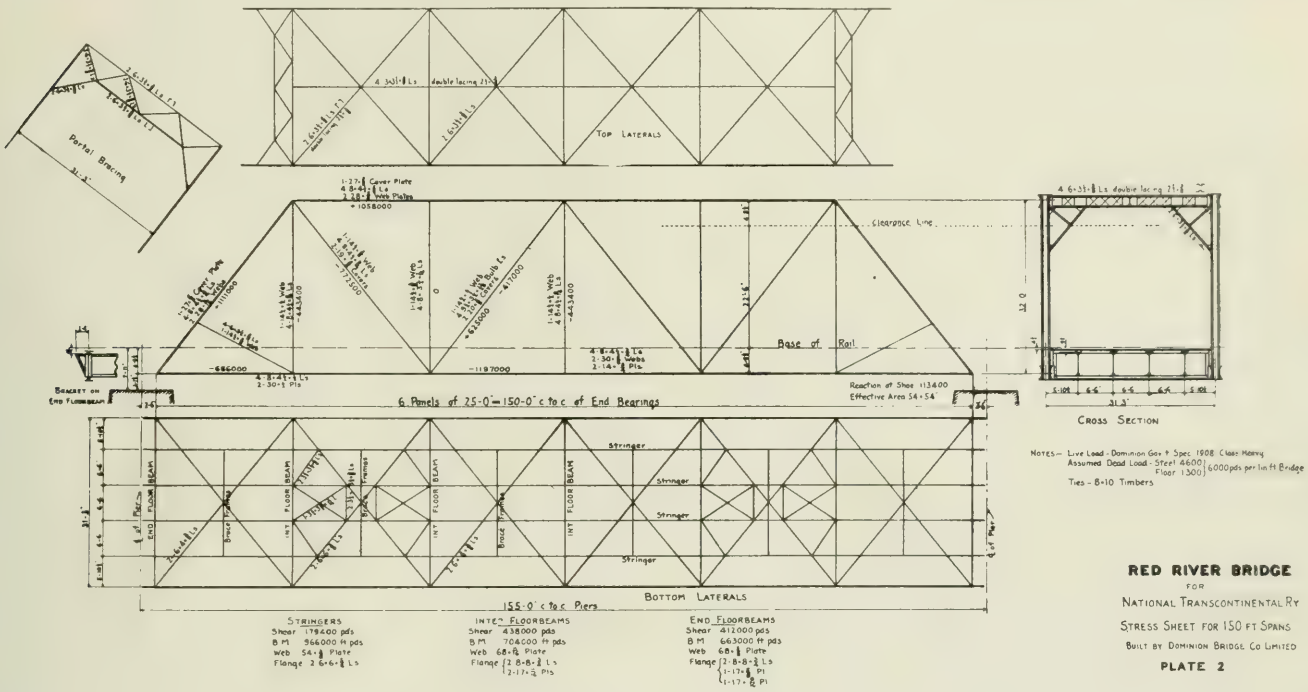
river piers there is an additional ¾ in. plate running continuously under the bed plate of the two adjacent spans. The spans are anchored at each corner by two 1¾ in. anchor bolts, 6 ft. 6 in. long, connecting to brackets on either side of the bottom chord, and running 2 feet into the masonry, set after the trusses are in place. It was desirable to have a fixed end next the toe of the bascule on pier No. 4, so the west ends of all four spans were made fixed and their east ends roller.

Leaving the bascule span in the meantime, let us note a few things in connection with the long viaduct of the western approach. Cross sections AA and BB on Plate No. 1 show typically the construction of the different portions. Except where the viaduct crosses over the tracks of the Winnipeg Transfer Co. and the other spur track, the cross section is as shown at BB, and similar to the span over Taché Avenue—four deck girders with 9-inch cross beams on top cantilevering out supporting facia girders. On the curve the superelevation of the outer rail is attained in the ballast of the floor. The longest and heaviest of the deck girders are the four spanning from pier 6 to the first bent. These are 54 ft. long centre to centre of bearings, and have each a 72 x 7/16 in. web and flanges of two 8 x 8 x ¾ in. angles, and two 18 x ½ in. cover plates. The smallest deck girder is one of 13 ft. 8 in. span at the 20 ft. 6 in. chord over the east side of Mill Street, and it has a 47 x ⅜ in. web and flanges of 2 ft. 6 in. x 4 x ⅜ in. angles. The 33-ft. girders have 46 x ½ in. webs and flanges, of two 8 x 8 x ¾ in. angles and one 18 x ⅜ in. cover plate, while the 36-ft. girders over Mill Street have 45 x 9/16 in. webs and flanges of two 8 x 8 x ¾ in. angles and one 18 x ⅝ in. cover plate. These deck girders have lateral bracing on the bottom flange only. In the 36 ft. 1¼ in. span over the Transfer tracks, deck girders would not have given sufficient under clearance, so through side girders were used, as shown on section AA, with one intermediate floor beam, which was skewed to suit the tracks and carries built stringers 27 in. deep, two under each track. The floor beam and the stringers were made flush on top with the 9-inch beams, so that these latter had to rest on shelf angles on the webs of the stringers and side girders; otherwise the construction is similar to the rest of the viaduct. A side view of this span is shown in Photo No. 1. The side girders are 70 in. deep. Crossing over the other spur track the span is only 23 ft. 7 3/16 in., so that there was no necessity for an intermediate floor beam or side girders, the stringers being plate girders 26 in. deep. Here, however, the supporting posts are only 19 ft. 6 in. apart transversely, and as the 9-inch beams do not cantilever it was necessary to put side brackets on the post, in order to carry the facia girders, which are 27 ft. 2 in. apart, and which are heavier than usual at this span, as they are designed to take the load of a derailed train, which load is ordinarily carried on the cross beams, cantilevering. The deck of the viaduct is carried throughout on posts and cross floor beams. The posts are 30 ft. apart crosswise for the through span and 19 ft. 6 in. elsewhere. The height from base of rail to top of concrete pedestals varies from 26 ft. 6 in. to 23 ft. 6 in. Most of the posts are made of three 24-in. I's at 80 lbs., but some are heavier, the heaviest being two at the sides of the Mill Street, composed of one 23½ x ⅝ in. web, four 5 x 3½ x ½ in. angles, and two 24-in. I's at 100 lbs. The heaviest cross girder is at the first bent west of pier 6, and has an 80 x ¾ in. web and flanges of two 8 x 8 x ¾ in. angles, two 18 x ½ in. plates, and

one 18 x 7/16 in. plate. Expansion was provided for at the points indicated on Plate No. 1; an apron plate was made to cover the tops of the cross beams adjacent to the expansion joint, to prevent the ballast from falling into the opening. The base of each post was anchored to the pedestal with two 1¾ in. anchors, and where a post is in a street the base is protected by a cast iron fender filled with concrete.

The cross section of the Thistle Lane span is shown on Plate No. 1. The floor beam was made parallel to the spur track. As the stringers were very close together it would have entailed considerable work to run a lateral system between them, so laterals were put only between the two centre stringers and between the side stringers and the main girders, the remaining stringers being connected up to this system with cross frames. The span over the next opening farther west is similar to the one at Thistle Lane, but it has no floor beam or side girders.

The spans at Notre Dame Street and Water Street have solid floors similar to the large viaduct, but the stringers are made flush on top with the cross beams and the side facia girders are carried on brackets from the post, as in the 23 ft. 7 3/16 in. chord of the viaduct. The stringers in both crossings are composed of one 44 x 9/16 in. web plate and flanges of two 8 x 8 x ¾ in. angles and one 18 x ⅝ in. plate. The facia girders are made 5 ft. 4¼ in. deep, which brings them flush on bottom with the main stringers and adds to the appearance of the bridges, as seen from the streets. In both cases there is a central bent, the posts and cross beams being similar to those of the long viaduct. In all cases where a ballast floor adjoins an abutment apron plates are used and the side facia girders are extended about 2 feet beyond the face of the ballast wall, so that there will be no possibility of the ballast escaping.



REINFORCED CONCRETE FOR HYPOCHLORITE SOLUTION TANKS.*

By Dr. Walter M. Cross.

During the year 1911 an experimental installation of the hypochlorite process for the approximate sterilization of the entire municipal water supply of Kansas City, Mo., was so remarkably successful in diminishing the sickness and death rate in the city on account of typhoid fever as well as other forms of intestinal disease, that the Kansas City Fire & Water Board undertook the construction of a permanent building and apparatus for the application of this purification process to the water supply.

A separate building was constructed to make possible the satisfactory storage, handling and making of the solution of hypochlorite ready for mixing with the sedimented water.

The building itself was designed by Mr. W. C. Root, architect, and the apparatus for use in connection with the sterilization process was installed under the direction and supervision of Mr. Burton Lowther, engineer in charge, and Mr. S. Y. High, superintendent of the waterworks department.

The apparatus for the handling of the hypochlorite and the supports for it are of reinforced concrete. It is to be observed that no other material is so well suited for use in connection with this sterilizing agent as good concrete for the reason that all other materials that are capable of oxidation are promptly attacked by the hypochlorite solution and become rapidly deteriorated. The prime consideration with regard to this class of installation is to employ such methods of construction and to use material that is so permanent in character as to obviate the necessity of repairs which would force the discontinuance of the application of the sterilizing agent even for an hour.

The basement of the building is used for storage of the reagent that is kept in reserve. The main floor is used to house the dilution tanks and the feeding devices, while on the floor above is placed the tank in which the hypochlorite

* From a paper presented at the eighth annual convention of the National Association of Cement Users.

is reduced to paste of a creamy consistency before being delivered to the dilution tanks beneath. This pasting tank, 3 ft. in diameter and 4 ft. high, is provided with a stirring device carrying two rather heavy rollers which are located horizontally at its lower end.

The rollers clear the bottom of the concrete tank only by a fraction of an inch, thus insuring the mashing and disintegration of all of the small lumps that are invariably present in commercial calcium hypochlorite. Owing to the fact that the action of the reagent on bronze is to form on the surface of it a fairly insoluble and protective coating of metallic carbonate and oxychloride, that metal appears to be the most available for use on all bearing and stirring or disintegrating devices that come in contact with the solution. Leading from the concrete pasting tank are pipes so arranged that the contents of the tank may be discharged into either of the large dilution tanks on the floor beneath. The outlet of the pasting tank is placed at a considerable distance from its bottom so as to avoid the possibility of drawing off with the paste any fragments of considerable size. The pipes carrying the paste are so arranged as to be readily cleaned in a few minutes in the event that they become clogged. Ultimately they are sure to become clogged if they are not occasionally cleared because of the formation in them of carbonate from carbon dioxide absorbed from the air.

The dilution tanks are hexagonal in form, 9 ft. in maximum diameter and 7 ft. high. Their walls are 6 in. thick. Although the difficulty experienced in properly disposing the reniforcing iron in the construction of a hexagonal tank is much greater than is the case in the building of a round one, the hexagonal tank is to be preferred on account of the fact that in a round tank a rotary stirrer does not produce nearly such thorough agitation and mixing of the solution of hypochlorite as the same stirrer can do in the hexagonal tank. The paste is mixed with water in the dilution tanks until a uniform solution of a strength of 2 per cent. occurs. The use of the two tanks makes it possible to adjust accurately the strength of the solution in one dilution tank while the contents of the other is being utilized. The dilution tanks are placed on supports high enough to permit the use of a gravity feed to the orifice box, which is placed on the floor of the room housing the big tanks.

Bronze pipes, 1½ in. in size, so arranged as to be readily cleaned in the event of stoppage, connect the dilution tanks with a gauging tank 4 ft. in diameter. This gauging tank contains a float, scale and pointer so arranged that the man in charge can accurately check the speed of outflow of solution from his orifice box into the big water main carrying the entire city water supply from the settling basins to the pumps. The solution passes through the gauging tank to the orifice box. Each division on the gauge represents 1 gal. of the hypochlorite solution.

The orifice box is oblong in shape and carries a float of about 250 cu. in. displacement. The float operates a valve which, by either opening slightly or closing, maintains the hypochlorite solution in the orifice box to a constant level. One end of the orifice box is of plate glass to enable the operator to see at a glance that the solution is filling the box to the proper height. Attached to the plate glass and covering a hole in it, is a hard rubber disc having near its periphery several slits, the adjustment of which represents the size of a stream of the per cent. hypochlorite solution that will be the proper amount to treat the quantity of water passing through the main. All movements of the hypochlorite solution after its preparation, are by gravity. Ample opportunity for the hypochlorite to react with any putrescible organic matter and germs in the water is afforded during the time in which the water passes through the centrifugal pumps, the flow line and a small storage basin at Turkey Creek before it is pumped to the domestic water users.

All of the stirring devices are run by an electric motor belted to a line shaft carrying clutches so placed as to make possible the running of any one of the stirrers whether or not any of the others are running.

The principle involved in the construction of practically all hypochlorite installations for the purification of water by the oxidation of germs and putrescible organic matter in municipal water supplies, is substantially the same as that in Kansas City. Concrete, usually reinforced, is universally used in the construction of all permanent apparatus for the preparation and solution of the hypochlorite for mixing with the water to be purified.

OIL-SHALE INDUSTRY.

Canadian capital interests of late have taken considerable notice of the industrial possibilities of the extraction of oil from the shale deposits of Eastern Canada. A short time back the Dominion Government conducted a number of experiments on these shales with a view of obtaining a report that would be of value in the industrial future of the properties covered by these bituminous materials. Fifty tons of the material were transported to Scotland and passed through the plant of the Pumpherston Oil Company's works, MidCalder, Edinburgh county, and from the resulting report we extract the following:

The testing of the New Brunswick oil-shales was conducted on a large scale, and with complete success, at the Pumpherston Oil Company's works, MidCalder, Edinburgh county, Scotland. The various operations were performed under the direct supervision of Dr. R. W. Ells—representing the Mines Branch of the Department of Mines, Canada—and of Mr. W. A. Hamor, assistant to Dr. Charles Baskerville, of the Science Faculty of the College of the City of New York—acting for the Albertite, Oilite and Cannel Coal Company, of that city.

In 1868 Prof. Henry Howe published a mineralogy of Nova Scotia, and concerning the oil-shales, reports in Hants county a 15 foot seam that will yield at least 20 gallons per ton. The non-productive coal-measures of Hants county afford large quantities of shale, which have led to the expectation of finding coal, but the amount of oil that they yield has not yet (1868) been ascertained. The deposits of shale in Antigonish county may be of the same age.

The centre of the Antigonish basin is occupied by highly bituminous limestone overlying the oil-coal and oil-shale beds and from this fact it is thought that the whole group is upper Devonian or lower Carboniferous rocks, which are not known in this country to contain coal beds of any value. On this point Prof. Howe mentions that in a depth of about 180 feet in the neighborhood of Windsor only one small seam of coal, some 6 inches thick, was found in 1864, and that in a shaft sunk at Hantsport in similar rocks, to a considerable depth, no coal was obtained.

The bituminous beds appear to be divided into two groups, the lower of which appears to be about 70 to 80 feet in thickness, 20 feet of which may be regarded as good oil-shale, including 5 feet of curly cannel rich in oil. The upper band, which lies in immediate contact with the limestone, cannot be much short of 150 feet in vertical thickness of strata, containing a large percentage of oil. Of this

great bed of oil-batt about 30 feet will in all probability yield from 20 to 25 gallons to the ton. The 5-ft. seam of curly cannel will yield at least 40 gallons crude oil per ton, and the 15 feet of the best section of the oil-batt will yield at least 20 gallons to the ton, and taking this as worth 25 cents per gallon at the shipping port, there are in all $370,533,325 worth of oil which can be obtained from 20 feet in thickness of strata, underlying 2,000 acres of land comprising a basin underlaid by at least 50 feet in thickness of beds rich in soil.

The quantity of oil-shale from the two mines at Pictou was about 4,000 tons, of the value of about $8.35 per ton at the place of shipment, and this was in part sent to oil-works in the United States. A portion of the stellarite was used in the Province to mix with ordinary gas coals as an enricher in the manufacture of illuminating gas. This shale was found in 1859.

By reference to Dr. H. S. Poole's map of the Pictou coal-field, published by the Geological Survey, 1904, the presence of this oil-coal is noted at a number of widely divergent points, so that it is evident that the material should occur in large quantity in this field. The raising of this mineral was stopped many years ago, on the discovery of the mineral oils in the United States shortly after 1860.

The shales tested in Scotland were from the County of Albert, N.B., and it is toward this locality that the capital referred to above has given the major portion of attention.

The commercial value of the oil-shale can be best inferred from a study of the prices and quantities obtained by distillation. Thus in the case of the shipment made from New Brunswick the yield of crude oil was found to be 40 gallons imperial, or 48 United States gallons, and of sulphate of ammonia 77 pounds. These, it may be mentioned, are practically the two most valuable substances obtained from the first distillation. A further series of distillations, or fractionations, will give other valuable by-products, but for the present the conditions attending the production of the crude oil and sulphate of ammonia may suffice, since for these two sufficient data is now available to form a fair estimate of the cost of manufacture, the value of the shales, and the possible profits to be expected from their manufacture.

Assuming the value of crude oil at present prices, per barrel, to be $0.025 per gallon, and of sulphate of ammonia, at £12 per ton, as $0.029 per pound, we have as the value of the shale tested in Scotland in 1908:—

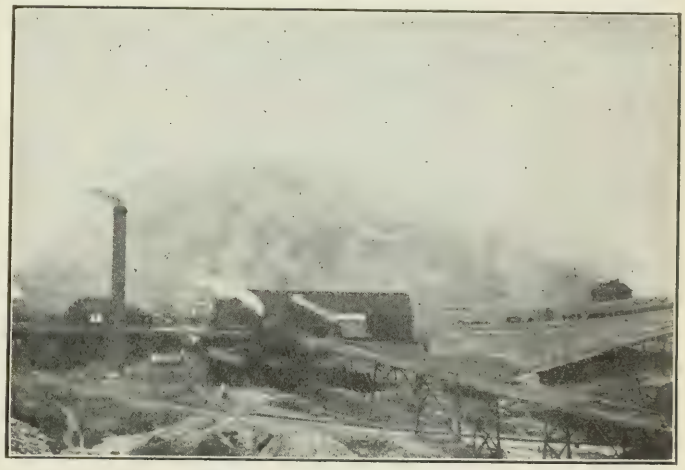
48 United States gallons crude at $0.025....	$1.20
77 pounds sulphate of ammonia at $0.029...	2.23
Bonus from government at 1½ cts. per gallon	.72
	$4.15

Should these oil-shales be worked and a new industry for Canada come into existence the engineer will find a new direction and field for the working of his profession.

Of late this great industry in Scotland has turned serious attention to the possibilities and application of electricity in the manufacture of oil from shales, and according to the Iron and Coal Trades Review, oil works in Scotland up to the year 1901 had not their power centralized or running economically, and it was often difficult to discern the nature of the work because of smoke and steam emanating from so many small steam plants. In 1901 the pioneer scheme for electrifying oil works was carried out by Messrs. J. Wishart and A. C. Thomson, of the Oakbank Oil Company, Limited, backed by a progressive board of directors. Many were sceptical, but the justification of the scheme is that nearly the whole of the Scottish oil companies have centralized their power and adopted electrical distribution. This has revolutionized the industry and enables the local firms to successfully compete with more fortunate oil companies in Russia, America, Galicia, etc., who have not to do any mining or retorting, but simply to bore for the oil.

To briefly describe the process, the shale from which the oil and ammonia are distilled outcrops in many cases at the surface. At Duddingston, for example, the mines were started in the mineral itself and the steam followed down. Some shales resemble slate in appearance, but the better qualities show a conchoidal fracture. Shale is in the Lower Carboniferous formation, and the following is a description of the working of an electric oil shale plant:—

In the upper portion of the retort the shale is heated to a temperature of 900 deg. Fah. and oil gas liberated Lower down in the retort the shale is subjected to a higher temperature, 1,700 deg. Fah. being maintained on the lower part of the retort externally. Some 80 gallons of water in the form of steam, per ton of shale, is sent into the bottom of the retort to aid in the formation of ammonia and to carry off vapours. The exhaust steam from the power-house is utilized in this way. If steam had not been necessary for this and other purposes of manufacture, oil engines would have been used as the prime mover. Exhausters are installed at the end of 24-inch gas mains and the gas is drawn from the retorts. It comes off at a high temperature



Breaker House, Showing Trams from Mine and to Retorts. Heaps of Spent Shale in Rear, Broxburn, Scotland.

and is conducted through multitubular heaters through which the feed water is passed. The temperature of the water is thus raised to 180 deg. Fah. The feed water then passes through a fuel economizer heated by the waste gases which heat the retorts externally. The feed water is at nearly 300 deg. Fah. before it goes into the boilers. After the gases have been condensed there still remains an incondensible gas which is scrubbed with water to remove the last trace of ammonia, also with mineral oil to remove the last trace of light spirit. One ton of shale can be mined and retorted on a consumption of 140 lbs. of coal.

The five boilers are of Stirling water-tube type and generate steam at 160 lbs. Chain-grate stokers are fitted, also an undertype conveyer for carrying away the ashes. The fuel is a dross having a mean calorific value of 10,700 B.Th.U. A CO_2 recorder is fitted which takes periodical quantitative analyses of the flue gases. It usually records 11 per cent. CO_2 gas.

The generating plant consists of two Westinghouse single-acting compound two-cylinder 18 by 30 by 16-inch engines coupled to Westinghouse 200-kw. alternators with belt-driven exciters; two Belliss-Morcom double-acting compound three-cylinder 21 by 23 by 16-inch engines and 500-kw. Twenty-five-cycle 3-phase Westinghouse alternators with direct-driven exciters. Each set has a generator panel consisting of isolating links, current transformer and ammeters, potential transformer, synchronizer, voltmeter plug and automatic oil switch. There are two shunt rheostats in the exciter field, one being mounted on the floor level for emergency, the other on the switchboard. There is also a rheostat in the rotating field. There are three single-phase (shell type) transformers 100-kw. each and one spare, transforming from 3,300 to 440 volts, and three 37 kw. single-phase and one spare to operate a 100-kw. rotary converter for use on the trolley wire. Another rotary of 150 kw. is also installed at the mines two miles away. They are run in parallel, both on A.C. and D.C. sides, which makes the drop on the D.C. a minimum. The transformers are delta on the high-tension and low-tension sides. The generators are star wound, the neutral being insulated.

The installation runs for months without a circuit-breaker coming out. The motor-driven exhausters have run for five years with a stop of only 1½ hours.

The trolley wire is No. 00, and the traction equipment consists of two locomotives each having two 25-horse-power series tramway motors geared to the axles. The armatures are in parallel, one resistance being used for both. The controllers are of tramway type with magnetic blow outs. Each locomotive will haul 20 wagons each containing 26 to 30 cwts. of shale. The wagons weigh 15 cwts. each.

A third locomotive has side rods and is fitted with a 100-horse-power series motor. It will haul 40 wagons. As the trolley wire has to pass under two roads and a railway arch it runs from 10 to 16 ft. above the ground. The trolley pole successfully follows the wire by the use of a long spring of 5-16 section and 33 turns 3-inch diameter.

The high-tension line has also to pass under the bridges and it is trifurcated into three-core cables at each bridge. The cable provides a good method of transposing the line. The trifurcating boxes are covered over, and the leads go through porcelain tubes. The reason for covering the box over was that the sun tended to soften the bitumen, and in one instance rain got in and caused a short in the box. Lightning has been on the lines twelve times, and none of the three cores has gone to earth.

The separation of costs in the operation of the plant is exceedingly difficult, as all economies are based upon lbs. of coal per ton of shale. The power required per ton of shale mined and retorted is eight kilowatts. The cost of running the power house, with maintenance, is 0.08d. per kw.-hour. The cost of running the locomotives is 0.05d. per ton mile. This includes cost of electric energy and the maintenance, etc. The steam consumption of the generating plant is 28.5 lbs. per kw.-hour, non-condensing.

THE STRIKE SITUATION.

There were three more strikes in existence, according to the Department of Labor's monthly record, in Canada during March than in February, and three more than in March, 1911. About 14 firms and 2,000 employees were involved. The loss in working days was estimated at 44,800, compared with 10,080 in February, and 33,600 in March, 1911. The only strike involving more than 200 employees was one of tailors at Toronto.

STRESSES IN FLOOR SYSTEMS OF REINFORCED CONCRETE BUILDINGS.

The following are extracts from the report of the Committee on Reinforced Concrete and Building Laws as presented by Prof. A. N. Talbot at the eighth annual convention of the National Association of Cement Users. The tests described in this report were made in the Wenalden building in Chicago and the Turner-Carter building in Brooklyn, both buildings of the beam and girder type of construction. The tests were conducted by members of the staff of the Engineering Experiment Station of the University of Illinois under the direct supervision of Professor A. N. Talbot and with the aid and co-operation of the contractors for both buildings.

The general method of the testing followed the plan outlined by Mr. Arthur R. Lord in the paper, "A Test of a Flat Slab Floor in a Reinforced Concrete Building," presented at the New York Convention. Holes were cut in the concrete until the reinforcing bars were bared and gauge holes were then drilled in these bars with spacings such as to give the proper gauge lengths. Where measurements of deformation of the concrete were desired, holes were cut in the concrete and a steel plug inserted in which the gauge holes were later drilled. These gauge lines were selected in places where it was thought that critical stresses would be determined. In some places for one reason or another the reinforcing bars were inaccessible and it was impracticable to obtain measurements to give information which would have been of interest. In some cases a series of gauge lines were used to determine the change of stress or distribution from one point to another as at the end of a restrained beam and across the flat slab between beams.

The measurements were made by means of Berry extensometers of the form developed at the University of Illinois. The instrument reads to 1/5,000 in. and is estimated to 1/10,000 in. In making measurement the legs of the instrument were inserted in the gauge holes, a reading taken, the instrument taken out and again inserted and read, and this proceeding repeated until a number of readings without serious discrepancies were found.

Wenalden Building Test.—The Wenalden building is a ten-storey reinforced structure located at 18th and Lumber Streets, Chicago. It was built by the Ferro-Concrete Construction Company, Cincinnati, Ohio, in accordance with the plans and specifications of Howard Chapman, architect. It is now occupied by Carson, Pirie, Scott & Company as a warehouse. The building is of the beam and girder type, with floor panels 15 by 20 ft. The girders are placed between columns in the short direction. Floor beams extend the long way of the panel, there being two intermediate beams built into and supported by the girders and a column beam built into and supported by the columns. The floor, 3⅞ in. thick (including the top finish), was built continuously with the beams and girders.

The reinforcement is the form used by the Ferro-Concrete Construction Company. The main reinforcing bars (twisted bars) are carried along the bottom of the beam from the end of a panel to a point beyond the middle of the panel where they are bent up to the top of the beam and carried horizontally to a corresponding point on the other side of the support, then bent down and continued along the bottom of the beam to the end of the next panel, these reinforcing bars thus having a length of two panels. In

the intermediate beams at the bottom and middle there are four rods ¾ in. square and in the side beams one rod ¾ in. square and three rods ⅝ in. square. In the girders there are four rods ⅞ in. square, the disposition of which is similar to that in the beams. By this plan there is twice as much of the main reinforcing steel in the bottom of the beam or girder at the middle of the span as there is at the top over the supports, except that four ⅜-in. square rods placed in the floor slab are also availale for end reinforcement of the intermediate beams. The beams are 6¼ in. wide and the girders 7½ in. The general position of the reinforcement is shown in the accompanying drawing. The position of the vertical stirrups is not shown.

The contractors report that the concrete was composed of one part Portland Cement, two parts torpedo sand, and four parts crushed limestone. Although the building was not fully completed when the test was made, the floor test had been built more than 12 months before the time of the test.

Method of Testing.—The test was made on the first floor of the building, which was the only one which could be reached with the loading material. At various points at the top and bottom of beams the holes were dug into the concrete until the reinforcement was bared and small gauge holes were drilled in the bars 6 or 10 inches apart for use in inserting the instruments with which the measurements of elongation were made. Where stresses in the concrete were to be measured, holes were cut in the concrete and short pieces of steel were set in plaster of paris. Gauge holes were drilled in these steel inserts in such a way as to give gauge lines 6 or 10 inches long. For the work of measuring deflections, steel balls were affixed to the under side of beams and girders at various places and other balls were placed about 7 in. lower on supports which had been built up independently of the observing platforms. A number of these points of deflection were used to determine the inflection points of the beams.

For any observation several instrument readings, usually five, were taken on each gauge line and these were averaged. Measurements were made on the calibration bar before and after each series of observations to permit corrections for instrumental changes.

Method of Loading.—The floor was designed for a live load of 200 lb. per square foot and the test load was made 400 lb. per square foot over panels loaded.

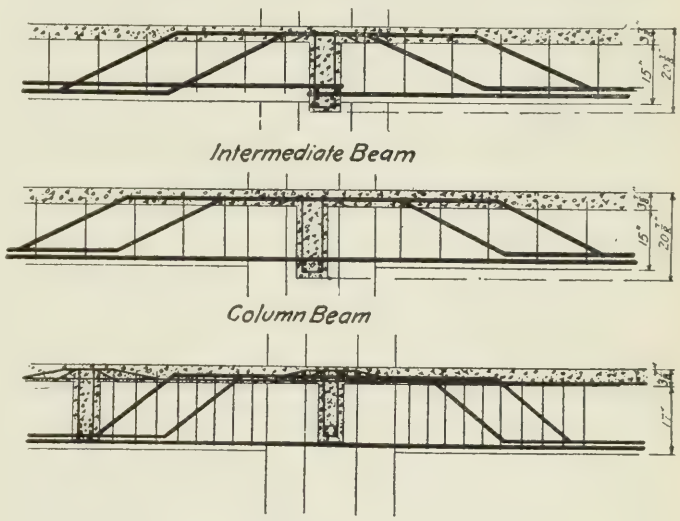
The loading was done by piling brick and bags of cement in piers separated by aisles in such a way as to give access for points of measurements and to prevent arching effects influencing the tests. The load was put on in increments of about 80 lb. per square foot of the total panel area, and a set of observations was taken at each increment of load. Brick was used in the first part of the loading and cement in the later work. The average weight of the brick was determined by weighing a considerable number and such care was given to determine the number of brick and sacks of cement that it is believed the weights of these materials are accurately known.

The following is the general plan of the test. A single panel was first loaded and this load was then removed. The load was then applied on three panels in tandem. Then, leaving this load on, a load was applied along three adjacent panels covering two-thirds of the width and making in all the equivalent of five loaded panels. The total load, which amounted to 60,000 lb., was then taken off by increments.

The Deformations and Stresses.—The results of observations for various gauge lines were plotted and from a study of these it was readily seen that the general trend of some of the lines should be taken rather than the absolute values.

In translating from unit-deformation to unit-stress the modulus of elasticity of steel was taken at 30,000,000 lb. per square inch and that of the concrete has been assumed to be 3,000,000 lb. per square inch. For simplicity the straight. line stress-deformation relation for concrete has been assumed, though it is evident that this relation does not hold for the higher stresses and that calculated stresses based upon this assumption are in excess of the actual stress The interpreted stress for a number of gauge lines is recorded in Table 1.

Table 2 gives calculated stresses and calculated bending moment coefficients. The first line of each set gives the calculated stresses in the reinforcement and in the concrete based upon the value of the bending moment quite commonly assumed in design calculations, 1/12 Wl, where W is the total distributed load on the beam and l is the span length. In these cases the span length was taken as 3 in. longer than the clear span. Measurements had been made upon the position of the bars and the depth of the reinforcement which were not always exactly according to the plans, and the calculations have been based upon the dimensions found. In the second line of each group the maximum stress obtained in the measurements is given in the column of stresses, and the bending moment coefficient (the coefficient of Wl) corresponding to these stresses is recorded in the adjacent column. In these calculations the common assumptions of design calculations are followed



Reinforcement in Wenalden Building.

except that the width of a T-beam is taken as equal to the distance from center to center of beams. In calculating the bending moment coefficient from the measured stress, the position of the neutral axis and the value of the moment arm are assumed to be the same as given by the ordinary assumptions. Although the stress in the reinforcement is measured at the surface of a bar of the outer layer, this stress is considered as being the same as that acting at the center of gravity of the group of bars, for the actual variation in the group is unknown and this method will give a bending moment coefficient larger than that found by considering that the stress in the bars of the other layer is smaller.

Table 1.—Stress Indications in Wenalden Building Test.

	Single Panel	Three Panels	Five Panels
Reinforcement at end of girder	.....	8,000	7,000
	7,000	12,000	13,000
	.....	.....	9,000
Reinforcement at middle of girder...	.....	10,000	11,000
	8,000	14,000	17,000
	6,000	16,000	17,000
Concrete at end of girder	1,100	1,600	2,200
Reinforcement at end of intermediate beam	.....	9,000	10,000
	2,000	9,000	14,000
	9,000	14,000	14,000
	9,000	16,000	16,000
	11,000	13,000	13,000
	13,000	13,000	14,000
Reinforcement at middle of intermediate beam	.....	14,000	16,000
	8,000	7,000	11,000
	.....	16,000	16,000
	6,000	11,000	11,000
Concrete at end of intermediate beam	.....	.....	1,300
	1,500	1,700	2,000
Concrete at middle of intermediate beam	Low	Low	Low

Table 2.—Maximum Stresses and Moment Coefficients in Wenalden Building Test.

Member	Reinforcement Stress	Reinforcement Coeffiient	Concrete Stress	Concrete Coefficient
Girder End	47,000	1/12	2,600	1/12
" End	13,000	0.023	2,200	0.07
" Middle	19,000	1/12	420	1/12
" Middle	17,000	0.075	.....	....
Intermediate Beam. End	36,000	1/12	2,500	1/12
" Beam End	16,000	0.037	2,000	0.067
" Beam Mid.	22,000	1/12	440	1/12
" Beam Mid.	16,000	0.061	.....	....
Column Beam, End ...	66,000	1/12	.....	....
" End ..	15,000	0.019	.....	....
" Middle.	26,000	1/12	.....	....
" Middle.	11,000	0.035	.....	....

It will be seen that in the tests with three and five panels loaded the highest stress observed in the reinforcement in the middle of the intermdiate beams was 16,000 lb. per square inch and the highest stress observed at the ends of the beams was 16,000 lb. per square inch. The stresses observed in bars having similar positions were lower, and probably the highest stress is not representative of the general stresses. However, it may be best to make comparison on the basis of the highest stresses.

The bending moment given in the table as derived from the measured stresses is 0.06 Wl at the middle of the beam and 0.037 at the end of the beam. Measurement of the compression of the concrete in this test was less satisfactory than the measurement of the reinforcement deformations, and considerable variation was found at the different points of observation. Not enough gauge lines gave satisfactory measurement to warrant making quantitative conclusions, but the indications of the action of the concrete may be useful. The value of the bending moment which corresponds to the concrete stresses, on the assumptions made, is 0.067 Wl for the end of the beam. For the middle of the beam the stresses were so small and the indications so irregular that no value of bending moment can be given.

In the beams at the sides of the panel (column beams) the stresses were in general somewhat lower, but with a full loading a stress of 15,000 lb. per square inch at the middle of the beam was observed and 11,000 lb. per square inch at the end.

Fewer measurements were made on the reinforcement of the girder. A stress of 17,000 lb. per square inch was observed at the middle of the girder and 13,000 lb. per square inch at the end. On the same assumptions these values correspond to bending moments of 0.075 Wl and 0.023 Wl, respectively. The stress in the concrete at the end of the girder was also very high, but the corresponding bending moment (0.07 Wl) is less than that for a restraining beam.

Calculating with the usual assumptions of beam formulas, the total compressive stress in the concrete at the end of the beam is greater than the total tensile stress in the reinforcement. Two elements probably enter into the results, the tensile strength of concrete which may be considerable as distributed over the width of the floor, and an arching action of the structure. However, it should be noted that the value of the bending moment coefficient derived from the reinforcement stresses at the middle of the beams and girder is not much less than values commonly used and also that the calculated resisting moment developed at the end of the beam based on the concrete stresses is not far below the amount usually assumed.

Attention should be called to the fact that the compressive stress in the concrete, both that calculated from an assumed bending moment and that calculated from the measured deformation, is much higher than that to be found by the use of the parabolic stress deformation relation and the actual stress will be less than that given in the table.

Measurements were made on the concrete at the top of the floor slabs in a direction parallel with the beams to find the distribution of compressive stresses between beams. These measurements were not fully satisfactory, but within the limits of accuracy of the measurements no difference in the amount of shortening over the beam and at points between beams could be determined and the whole floor evidently acted as a part of the compression member of the T-beam so formed.

Test Cracks.—The surface of the beam and girder had received a white coat, which permitted very fine cracks to be detected, much finer than may be observed on uncoated concrete. In the test, as the load was applied, fine tension cracks in the concrete through the middle of the length of the beam were observable at stresses in the reinforcement corresponding to the stresses at which load cracks are detected in the tests of beams in laboratory work. To an experienced observer development of the cracks was confirmation of the measurements of the low stresses developed in the reinforcement. Upon removal of the load most of these cracks closed until they were not visible to the eye.

As the calculated reaction on the end of a girder was upward of 40,000 lb., it will be seen that the vertical shearing stresses were very high. Diagonal tension cracks developed in these girders just outside the junction with the intermediate beams, making an angle of nearly 45 deg. with the horizontal. These cracks did not entirely close on the removal of the load. No measurements were taken to determine the diagonal deformations. It seems probable that the restraint at the end of the girder and the tensile strength of the concrete acted to prevent the fuller development of these cracks. No diagonal cracks were observed in the beams. As may be expected, the deflection in the middle panel was greater for one panel loaded than when three panels were loaded.

POTASH IN "BORAX LAKE."

The two Federal Bureaus of the United States engaged in the search for potash—the Bureau of Soils of the Department of Agriculture, and the Geological Survey of the Department of the Interior—are in receipt of promising telegraphic news from their field representatives. A potash deposit of apparently great importance has been discovered at Borax or Searles Lake in the northwestern corner of San Bernardino County, California. This lake or playa is the last remaining pocket of a once much greater lake which has almost dried up and its central depression contains a large body of crystalline salts known to consist of common salt and sulphate and carbonate of soda with smaller quantities of borax. This salt body is saturated with brine, and interested persons, stimulated by the governmental search for potash, recently secured an analysis of old sample material from this brine. The result being significant, the lake was visited jointly by representatives of the Geological Survey and of the Bureau of Soils, who took brine samples from six wells distributed over the salt flat. Analyses of these samples have been made by the co-operative laboratory at the Mackay School of Mines, at Reno, Nevada, and show an average of 6.78 per cent. of potassium oxide (K_2O) in solution. The average salinity of the brine is 43.82 grams of the solids per one hundred cubic centimeters. Comparison of results indicates that the brines are nearly uniform throughout the flat. The probable importance of the deposit is due to the occurrence of the potassium salts in soluble form in a natural saturated brine, and under climatic and other conditions especially favorable to its separation and recovery by solar evaporation. Existing data give reasonable assurance that the brine saturated salt body is at least 60 feet thick and covers an area of at least eleven square miles. Assuming the salt body to contain twenty-five per cent by volume of the brine, the total amount of potassium oxide is estimated at over four million short tons. This estimate is believed to be very conservative, and the available tonnage may well be expected to exceed ten million tons, which would supply the country, at the present rate of consumption of potash, for thirty years. At any rate, it appears that this locality constitutes a very important source of potash in probably readily available commercial form.

Methods of separating potash from brines are now under investigation by the Bureau of Soils.

Borax Lake or Searles Lake is one of the many playas or intermittently wet and dry lakes common throughout the arid regions of the West. It lies between the Argus and Slate ranges, in the Mohave Desert of Southern California. Borax Lake was the original scene of the famous 20-mule team borax mine, the borax being hauled in great wagons drawn by 20 to 28 big mules to the Southern Pacific Railroad at Mohave, a distance of 80 miles. The lake or flat is about 10 miles long and 5 miles wide, and has received the drainage from the surrounding hills for many thousands of years, vast quantities of dissolved minerals being thus concentrated in it. The water has been evaporated under the intense heat of the long, hot seasons, but the salts have remained, so that for most of the year, in fact often throughout the year, the bed is a glistening plain of white salts, in attempting to cross which under a brazen sun men have lost their lives.

The mirage plays its strange tricks here, and at the dryest places the traveller can generally see what appears to be a broad expanse of water covering the bed a little way ahead—always a little distance off, until he approaches the shore of Borax Lake. Then, when he looks behind him, he sees the water apparently covering the ground over which he has just come. The lake occupies a valley made by faults—breaks and slips in the earth's crust—where a great area has been dropped down. Borings have been made through the mud and water underlying the lake to a depth of some hundreds of feet, the deepest borings made bringing up hot mud.

A reconnaissance of the general region was made by one of the geologists of the United States Geological Survey in 1900, and is described in the Survey's Bulletin 200, now out of print. Borax Lake itself, however, was not visited. The lake is also shown on a map in Water-Supply Paper 224 of the Survey, "Some Desert Watering Places in Southeastern California and Southwestern Nevada." Its nearest railroad is the Owenyo branch of the Southern Pacific, running from Mohave past Owens Lake. Borax Lake is situated about 20 miles from the station of Searles, on this railroad.

Many useful and curious minerals are found in the muds and other deposits of Borax Lake, including, of course, borax. Among them are gypsum, glauberite, carbonate and sulphate of soda, salt, thenardite and hanskite. The last carries as much as 2.33 per cent. of potassium, equivalent to 4.44 per cent. of potassium chloride.

The salts are not evenly distributed over the surface of the lake. Borax was found plentifully over about 3 square miles, common salt is everywhere, and sodium carbonate and sodium sulphate are widely distributed. One boring is said to have passed through 28 feet of solid trona (hydrous carbonate of soda) of great purity. At other places there is 25 feet of solid mixed sulphate and carbonate of soda with smaller quantities of other salts. Although the lake bed is dry most of the time, a few inches under the outer crust there is always water—a bittern heavily impregnated with salts.

Several years ago an English company attempted to work the soda deposits on an extensive scale, but for some reason the work has not been pushed. This company sunk a number of wells, casing them through the soda deposits. It was found that a heavy stream of water could be pumped continuously without preceptibly lowering the water level. Potassium chloride and sulphate, the forms in which potash salts are most likely to be found in such deposits, are among the most soluble of salts and are likely to be much more generally diffused than salts less easily soluble. That the entire body of water and mud in the lake contains potash in a more or less uniform degree, is indicated by the results thus far attained. However, there are modifying agencies, such as springs and streams, that bring in fresh water, for the movement of water through the lake will be slow owing to the presence of the sand and salts that fill the basin.

RAILLESS TRAMS IN LONDON.

It is announced by the Highway Committee of the London County Council that they have decided provisionally to recommend the council in due course to seek authority in the Session of Parliament of 1913 to enable it to run cars on the railless trolley system of electric traction on certain routes. In order that the information which will be required to be given as evidence in support of the bill may be prepared, it will be necessary for certain experiments to be carried out and for diagrams and drawings to be made, and they therefore ask the council to sanction the expenditure of $1,000 for this purpose.

BRIDGES AND RAILWAYS IN NOVA SCOTIA.

It must appear to a casual observer that the eastern portions of this country do not, in a general way, receive the same amount of publicity as falls to the lot of the central and western parts. The reason for this might be difficult to state, but that the Province of Nova Scotia is not lacking in government engineering enterprise is amply demonstrated by a report recently issued from the offices of the Provincial Engineer at Halifax. In this report the matter of provincial railways is shown to be in a satisfactory condition, but no construction work was attempted during the past year. Railway surveys and preparations, however, have been exceedingly active.

The Intercolonial Railway with a mileage of 467 miles, owned and operated by the Federal Government, and coming under the control of the Minister of Railways; the Dominion Atlantic Railway with a mileage of 221 miles, coming under the jurisdiction of the Railway Commission; and the following lines coming under the jurisdiction of the Government of Nova Scotia and therefore under this Department:—

Cape Breton Railway Company with a mileage of	31	miles.
Colchester Coal and Ry. Co. with a "	4	"
Cumberland Coal and Ry. Co. with a "	32	"
Halifax and South Western Railway—		
Halifax to Yarmouth with a "	247	"
Bridgewater to Middleton with a "	55	"
Liverpool and Milton with a "	5	"
Mahone to Lunenburg with a "	7	"
Caledonia Branch with a "	22	"
Victoria Beach Branch with a "	40	"
Inverness Railway and Coal Co. with a "	61	"
Maritime Coal, Ry. & Power Co. with a "	15	"
Midland Railway with a "	58	"
Minudie Railway Company with a "	6	"
Nova Scotia Steel & Coal Co.'s. Ry. with a "	12	"
Sydney and Louisburg Railway with a "	52	"

A total of ten companies with a mileage of 647 miles.

Owing to the fact that there has been little or no railway construction in the Province for the last two or three years, whereas the railway mileage in Canada has increased very greatly, Nova Scotia, which three years ago had one mile of railway for about every three hundred and fifty people and which had almost as much mileage in proportion to its population as any part of Canada, is now somewhat behind in that respect.

The last returns show a mileage of 1,333 in Nova Scotia for a population of about 500,000 or one mile for every 370 people whereas that of Canada shows a mileage of 25,400 with a population of 7,200,000 or one mile for every 285 people.

On the completion, however, of the Halifax and Guysboro Railway, which is now an assured fact and which will add about 10 per cent. to the mileage in Nova Scotia, this will probably bring us very nearly up to the same proportion as that of Canada and in any case will then provide almost all parts of Nova Scotia with railway accommodation.

The returns for the year show an increase of nearly twenty per cent., so that there is a general improvement as regards gross receipts. As regards operating expenses there is also a considerable increase, so as to overbalance in some cases the increase in receipts, thus reducing the net receipts below that of last year. On the whole, however, there is ms a general increase in the net receipts, there being an increase in the Inverness Railway and Coal Company, the Maritime Coal, Railway and Power Company and the Sydney and Louisburg Railway.

As has happened for the last four or five years, the Cape Breton Railway and the Nova Scotia Steel Company's Railway show a loss on operation for the year. The Sydney and Louisburg, the Maritime Coal, Railway and Power Company and the Inverness Railway and Coal Company show a profit of between $1,500 and $1.650 per mile, equal to over five per cent. on $30,000 per mile, certainly a very good showing. The Halifax and South Western Railway and the Cumberland Railway and Coal Company show a small profit.

If we examine the operating expenses, however, we find as usual a great difference between the various companies, but not nearly as much as usual. This is probably due not so much to the fact, that there has been a change in the working of some of the lines, but that the figures are more correctly made up as far as train mileage is concerned.

The receipts per mile vary from $280 in the case of the Cape Breton Railway Company to $8,763 in the case of the Sydney and Louisburg Railway and the operating expenses from $587 in the case of the Cape Breton Railway Company to $7,134 in the case of the Sydney and Louisburg Railway.

The Government of Nova Scotia undertakes the construction of all large bridges and the majority of these bridges are of iron and steel superstructure with abutments of concrete. The steel superstructure is in all cases let by tender and contract, the contract including not only the supplying of the materials but its erection and the providing of the flooring. The piers and abutments are constructed and built by the Department by day labor. During the past year contracts for the erection of the iron and steel portions of eighteen bridges, with a total of twenty-seven spans. The largest of these bridges was constructed at Wallace Harbour, N.S. The distance across this stretch is 3,110 feet.

After careful examination it was decided that the most economical method would be to build five spans of 100 feet, one of 150 feet crossing the main channel and a draw span of 100 feet, making a total of seven hundred and seventy-three feet over all, including the piers, with an embankment of earth protected with stone for the remaining twenty-one hundred feet.

Careful soundings were taken, and in the channel at a depth of 27 feet below low tide mud and oyster shells were encountered, which continued for about 25 feet more to solid rock. This rock was found to continue across the whole bed of the stream at pretty much the same level, but rose gradually towards the shore. The surface of the mud at the abutments being about 12 feet, and the surface of the rock about 18 feet below high water.

Owing to the prevalence of the Teredo it was necessary to have all the submerged timber in the foundation creosoted. Creosoted cribs were built on the shore and floated into place, piles were driven, spaced about 4 feet apart, and the cribs were filled with rock, the whole being brought up to a little above low water. On this foundation the concrete was started, and carried up to the top of the piers and the whole work was done by day labor. The embankment of earth and stone contained about thirty-seven thousand yards.

This work was carried on along with the work of the substructure under the superintendence of Mr. Thomas Rawding, and the season closed with the work practically completed and for a much less sum than that of the lowest tender and the whole work reflects great credit on the skill and economy with which it was carried out by the superintendent.

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ICEBERG DETECTION.

The recent terrible catastrophe, in which the White Star liner, Titanic, collided with an iceberg on her initial trip, brings to mind a question of the possibilities of preventing such accidents. The detection of icebergs by means of thermometer reading has been considered for some time, but until within the last few years no practical results seemed possible. About eleven years ago Dr. H. T. Barnes Macdonald, Professor of Physics of McGill University, investigated the condition underlying the formation of frazil and anchorites by means of the micro-thermometer. Since that time the micro-thermometer has been developed, until now it is possible to determine temperature variations of water of a few thousandths of a degree. This highly-developed instrument records temperature so minutely as to pick out the slightest variation in sea temperature, and opens up a new field of work in studying the small variations in the surface temperature of the sea. Investigations carried on during the past two years show that the micro-thermometer is capable of recording a temperature gradient of one-tenth of a degree per mile with accuracy. There appears to be little question that it will become an important instrument in the detection of icebergs in ocean travel, for the tests already made show that it is capable of such detection up to a distance of two miles, and the effect remains for seven miles past the berg. If the Titanic had been equipped with such an instrument, even at the present state of its development, no doubt the accident would have been prevented.

As noted by Dr. Barnes, there remain a number of problems to be solved in connection with the successful application of the micro-thermometer to the detection of icebergs. They are, however, academic questions, and, while it is unsafe to predict the whole result of the most unfavorable conditions until experiments are actually tried, still it appears that where navigation is most important the conditions are the best for the operation of the micro-thermometer.

WATER POWERS IN NEW YORK STATE.

During the past five or six years there has been great agitation throughout New York State to induce the Legislature to take over the development of all water powers, and the generation, transmission and sale of electric power to the municipalities and factories of the State. Up to the present time, those favorable to the proposal have been unable to secure legislation. On March 27th a measure was passed by the Senate, in line with the State Conservation Commission requests, providing for the development of the State-controlled water powers. Considerable objection was raised to the measure, it being claimed by the opponents of the bill that if the State developed its water powers they would be compelled to buy private water powers and establish steam plants to be able to furnish 1,500,000 horse-power, which is the amount used in the State, as the State water powers have a maximum capacity of only 220,000 horse-power. In his explanation of the provisions of the bill, Senator Bayne stated that it proposed to give the people the sole benefit from the development of the water powers of the State, and the consequent generation of electricity, instead of turning the State resources over to private corporations. Under this bill the State will develop and distribute electric power made possible by the construction of water storage dams directly to muni-

cipalities and factories, without permitting private corporations to act as middlemen.

If the above measure is carried into force, as no doubt it will, it will be a great benefit to the citizens of the States. The State-owned water powers are practically all of them storage propositions, so that their development will mean many other advantages to the State, in the prevention of flood conditions and the conservation and regulation of the water supplies.

New York State has gone a step farther than the Province of Ontario, in that the State will develop its own power, while the Province only distributes power bought. It is only a question of time, however, until Ontario, if the Hydro-Electric policy is to be a success, must develop auxiliary water powers to tie with the present system, in order to relieve peak load condition, and this, no doubt, will mean water storage conditions similar to those confronting New York State.

GAS-ELECTRIC CARS.

The development of the steam locomotive has almost reached a climax. The highest possible state of efficiency has been obtained, and, while it may increase in size, still the steam locomotive as a piece of mechanism is very nearly perfection. The application of oil fuel to the locomotive has opened up the final field, and a number of these oil-burning locomotives are now being used in the West. A new era has dawned for Canadian roads in the use of the gas-electric motor car on a steam line. The Canadian Northern Railway have just bought a new gas-electric car for tourist use between Quebec and Indian Lorette. This is the first car of its type to be used in Canada, and the Canadian Northern are to be congratulated on their enterprise. The cost of operation of such a car, including all maintenance charges, roadbed, etc., averages about eighteen to twenty cents per car mile, although on one line in the United States the operation costs have been reduced to about eleven cents per car mile. The cost compares very favorably with the electric trolley, and there seems to be no reason why there should not be a widespread use for these cars in Canada. For suburban service and for building up feeder and branch lines their use is amply justified, and there is no doubt, now that the car has been developed to a practical state of efficiency, that other roads will see the advantages of their use.

EDITORIAL COMMENT.

The University of Manitoba has been having many difficulties with regard to methods of finance. The early days of educational institutions are usually troubled ones. We are glad, however, to understand that the University Council and the Provincial Premier have had a conference, at which it was decided to re-organize the University and provide additional land for expansion.

* * * *

Steel street cars are rapidly growing in favor. There have been many new installations recently in the United States and a few in Canada. The Ottawa Electric Street Railway Company has just placed an order for twenty new steel cars, the entire construction throughout being of steel, except for the doors and windows. As wood becomes more and more costly and the uses for steel increase, we will probably see greater numbers of these cars in use.

ONTARIO PORT ON HUDSON BAY.

Now that Ontario is to have a port on Hudson Bay, the harbor facilities on James Bay are a matter of considerable importance. Mr. Sydney C. Ells has completed a report of an exploration trip in that vicinity.

From time to time and in a very general way in considering a possible terminus on tide water at James Bay, the estuaries of three rivers—the Albany, the Moose and the Harricanaw—have usually been mentioned. All three streams are of considerable size, are old-established canoe routes—especially the Albany and the Moose—and all lie within the boundaries of the Province of Ontario. Incidentally, it may be said that, apart from these three locations, there is absolutely no other point on James Bay (and within the boundaries of this province) where a potential tide-water terminal can be said to exist.

Regarding the first of these—the Albany River—the stream is for a distance of several miles above its mouth divided into minor channels by numerous islands. The force of the main volume of the river is thus dissipated, with the natural result that many bars and shoals everywhere obstruct the narrow channels. At the outer bar, sailing boats drawing three feet of water must wait for the tide before coming in. In the face of existing conditions, it is, indeed, difficult to understand why the estuary of the Albany should ever have been seriously considered as a possible harbor site.

In the case of the two remaining possibilities, Mr. Ells reports that the estuaries of the Moose and of the Harricanaw, conditions appeared somewhat more favorable. Preliminary surveys were, therefore, made at these two points. The plans which are the result of this work are submitted herewith, and will serve to roughly illustrate such relative as well as absolute advantages as may be looked for at either of these places. In each case some uncertainty still exists regarding the exact range of spring and neap tides, all observation regarding rise and fall being made during the progress of the surveys, and, therefore, extending over but a limited period.

RETURN OF CREDENTIALS.

LETTERS TO THE EDITOR.

To the Editor.

Sir,—Perhaps the experience gained by the writer in answering advertisements in technical papers for engagement in professional work may be of some advantage to others.

In answer to one firm, having gone to a good deal of expense in order to place clearly the extent of his experience, the writer asked that certain typewritten documents, being copies of his credentials and testimonials, might be returned, facilitating in every way the return of the same, but though he has written again he has not been favored with the return of the documents.

If the applicant's qualifications were not suited to the special requiremens demanded, there surely was no need for such a lack of common decency. Granted that in many cases we are generally foolish enough to sell hard brainwork for a remuneration less than manual work we at least hope to be treated with a little more consideration than is generally meted out to a foreign laborer, and due to the small remuneration we are not in the position of some big manufacturing company, that can distribute gratis such copies of their credentials and papers with little felt expenditure.

AN ENGINEER.

A NEW WATER-TESTING DEVICE.

Engineers and superintendents of municipal water supply plants have often wished for a means of determining a change in the composition of the water without resorting to the usual tests as conducted along chemical lines.

There are not many principles on which to establish a method of determination outside of the fact established by Kohlrausch that the electrical conductivity of pure water containing any electrolytic substance in solution is due almost entirely to the dissolved substance, and not to the water itself. The following table is the result of a series of experiments conducted with a view of determining the relative conductivities of waters usually reported as pure.

Source of Water.	Conductivity at 20° C.
Distilled Water:—	
Obtained by F. Kohlrausch, after occupying ten years in cleaning the glass receiver of the distilling apparatus	0.2
Supplied by Messrs. Hopkin & Williams, London; an abnormally pure sample	1.2
Supplied by Messrs. Hopkin & Williams, London; average of several samples	2.0
Supplied by a retail chemist, Birmingham	5.0
Supplied by a retail chemist, London	8.0.
Supplied by a retail chemist, London, (another sample)	14.0
Condensed water, from the hotwells of condensing engines:—	
Shoreditch Electricity Works, London	3.3 (a)
Westminster Electric Supply Corporation, Eccleston Place Station	3.6 (b)
Messrs. Belliss & Morcom's Works, Birmingham	11.7 (c)
Public Water Supplies:—	
Glasgow, from Loch Katrine	34
Manchester, from Thirlmere	48
Blackburn	65
Birmingham, from Rhayader, Wales	80
Dewsbury	109
Glasgow, from Gorbals Waterworks	119
East Surrey Water Company, from wells in chalk (softened by Clark's process)	135
London, West Middlesex District (after softening by Clark's process)	163
London, West Middlesex District (after softening by boiling)	180
Southampton	185
Paris	312
London, West Middlesex District (as supplied by the Metropolitan Water Board)	390
Cooling Water:—	
Westminster Electric Supply Corporation, Eccleston Place Station	472
Messrs. Belliss & Morcom's Works, Birmingham (canal water)	1,760
Sea water; average of samples taken off Harwich and off the Isle of Wight	50,000

(a) This is the lowest value observed by Mr. Digby.

(b) This is the calculated value for no leakage; the lowest value observed by Mr. Partridge was 4.1.

(c) The condenser was in perfect order, and the high value is probably due to the discontinuous working of the steam plant.

Working upon this fact there has of late been perfected an apparatus known as the Dionic water tester, the joint invention of Messrs. Digby and Biggs, of England, and introduced to the American continent by Mr. James G. Biddle, of Philadelphia, Pa., U.S.A.

This apparatus is not used to supplant the usual chemical determinations, but is used as an indicator of any variations in the organic contents after their quantities have been determined by a chemist.

The complete apparatus is shown in Fig. 1, where G is a bent glass tube to contain the water under test, and A and B are the electrodes for passing the electric current through the water. The electrodes are connected by wires to a direct-reading conductivity meter M, and a continuous-current hand-driven dynamo E; so that by turning the handle W of the dynamo, a current traverses the meter and the water in the conductivity tube G. The pointer of the meter is deflected, and comes to rest at some point upon the scale which directly indicates the conductivity of the water in the tube. The test is completed as soon as the pointer has come to rest, usually in two or three seconds.

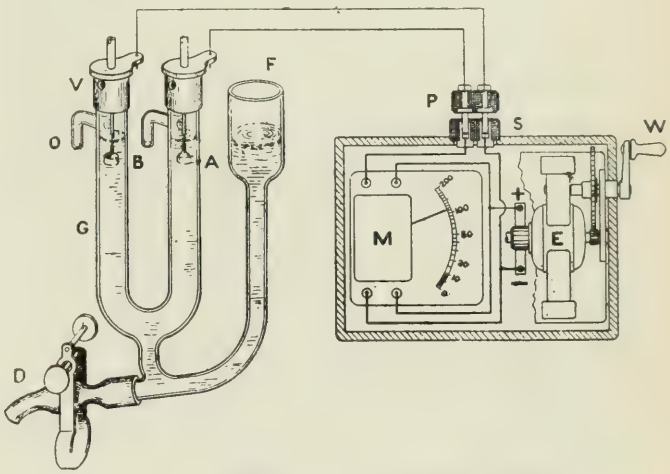

Fig. 1.—Diagram of Dionic Water Tester.

The tube G is made long enough, and the electrodes are given sufficient surface, to make the electric resistacne in the parts of the current-path immediately surrounding the electrodes negligibly small compared with that of the length of water in the tube. Hence, gas bubbles may accumulate on the electrodes without making any observable difference in the measured conductivity. Moreover, gas bubbles liberated from the electrodes rise upwards and escape freely at the upper ends of the tube; they can never diminish the conductivity by traveling downwards into the path of the electric current. The electrodes are short hollow cylinders of platinum, so that they present a large surface, from every part of which gas bubbles are free to escape upwards.

Whatever gas is formed in the electrodes is very small and is all washed away when fresh water is poured through the tube preparatory to another test.

Although the current used is very small, never exceeding .004 amperes under normal conditions, and the time during which it flows is very short, there is more than enough time to establish the maximum polarization of the electrodes: so that unless some means were adopted to eliminate it the error due to back-electromotive force would be considerable. This difficulty is removed by taking the electromotive force into account when calibrating the scale of the conductivity meter. Evidently, any back-electro motive force will make the conductivity of the water in the tube appear to be less than it really is; and what is done is to mark the divisions on the scale so that they represent

the true conductivity of the water. To do this it is necessary to take a fair average value for the back-electromotive force of polarization. With bright platinum electrodes in a dilute salt solution the back E.M.F. is about two volts, and this is the value allowed for in marking the scale. The dynamo generates a constant pressure of 100 volts, so that any variations in back E.M.F. above or below two volts are negligibly small by comparison and do not produce any observable error. To maintain the necessary constancy of pressure the dynamo is fitted with the constant-speed clutch. The effect of this device is to keep the pressure constant at 100 volts within one-quarter of a volt, when the dynamo handle is driven at any speed above that at which the clutch is adjusted to slip.

The conductivity meter measures directly, and without calculation, the conductivity of any electrolytic solution in the tube to which it may be connected. The indication is given by an index which ranges over an engraved scale, graduated in units of conductivity.

Conductivity (specific conductance) is the reciprocal of specific resistance, and the most convenient for the purpose of water-testing is the reciprocal of one megohm. No one has given a name to the reciprocal of one megohm, and we must be content to call it simply one unit. In the conductivity meter the scale extends from zero up to 2,000 units.

Referring to Fig. 1, it will be seen that the conductivity tube is so constructed that by pouring water into the funnel F, and allowing it to overflow through the outlet pipes O O, every part of the tube is thoroughly washed out, and any products of electrolysis which may have accumulated upon the electrodes are at the same time swept away by the water. The air vents V V ensure a steady flow from each outlet without any syphoning action. A drain pipe D of pure rubber is provided at the bottom of the tube for the purpose of drawing off the contents at the conclusion of a test. Normally, the drain is closed by a pinch-cock. Water may be left standing in the tube for days at a time without the slightest trace of contamination from the rubber finding its way into the conductivity tube. The only other materials in contact with the contents of the tube are glass and platinum.

The tube is mounted on a strong teak stand designed to afford as much protection as is consistent with accessibility.

The conductivity meter and dynamo are fixed inside a box and once for all connected up to each other and to the terminals of the socket S, which is fixed on the outside of the box. The two-pin plug P is permanently connected up to the electrodes A and B by means of a short length of well insulated twin-flexible cable. Hence, all the user has to do in order to connect the tube to the meter is to push the plug into the socket.

The dynamo and conductivity meter do not need any attention, and, in fact, the box containing them is closed and sealed by the makers. The dial is visible through a window in the top of the box, and the handle of the dynamo is folded back into a recess when not in use.

In making a test the conductivity tube is placed at the edge of a table or bench, so that the overflow and drain pipes may discharge into a vessel of some sort standing below. The meter-box is put down close alongside the tube. The connecting plug is disengaged from its place on the tube-stand and pushed into the socket on the meter. Then the pinch-cock is opened for a moment to make sure that no water previously tested remains in the drain pipe. When the pinch-cock is closed again, the water to get tested is poured into the funnel and allowed to run out of the overflow pipes, until at least a whole tubeful of the water has been discharged. In this way any traces of previous tests are thoroughly washed out. After the dynamo is speeded up and the index needle comes to rest a note is made of its position on the scale and the temperature of the water.

The conductivity of a water is an isolated and barren fact in itself, but becomes a valuable factor when comparisons are available with a known composition, and may be used in many ways, as shown by the following examples.

After the source of hardness in a water is determined by chemistry periodic teste with this apparatus will indicate the slightest changes in the composition of the water as regards the amount of calcium or magnesium carbonates, and it is quite possible after a few experiments to deduct with accuracy the parts per million or the grains per gallon of these constituents. It is also possible to prepare a series of plotted curves of the results of the readings after certain known quantities of quick lime have been added as a softener. As the quantity of lime is increased the conductivity diminishes until a minimum is reached, beyond which the conductivity of the water is increased. The point of minimum conductivity indicates the correct quantity of lime.

In such cases where it is desired to keep a check on the purity of a water supply the use of this instrument dispenses with all analysis excepting the first one to establish the quality of the organic contents; reading obtained at frequent intervals and showing no important variations in the reading will indicate that no changes in the organic contents or purity of the water. By this means the cost of testing is practically confined to the initial outlay for the instrument. The instrument may also be employed to indicate leakage from a surface condensor for boiler priming, for measuring the solution of rivers for periodic tests at sewage works, for the determination of the relative purity of distilled water and for many other purposes.

CAR WORKS AT PORT ARTHUR.

A group of well-known Eastern Canadian financiers and manufacturers, headed by Messrs. F. B. McCurdy, J. R. McLeod, F. M. Brown, and their associates, have concluded arrangements with the city of Port Arthur for the immediate erection of a modern steel and wood car plant, with a capitalization of $5,000,000. These people are the organizers of the Nova Scotia Car Works, Limited, which is operating successfully in the city of Halifax.

For some time past negotiations have been under way between this syndicate and the representatives of Port Arthur. At a meeting of the board of trade and the council of the city of Port Arthur, all details were finally decided on by which the company, which will be known as the Ontario and Western Car Company, Limited, will establish its plant. The company will employ 1,000 men and as the plant will be located at the head of navigation, the center of Canada, it will be in a position to supply freight and passenger cars to the various transcontinental railways at the point where they are most needed. It will also, owing to the geographical location, be able to assemble materials more cheaply, and therefore build cars at a lower cost than any other plant in Canada.

A great deal of credit is due to the Industrial Commissioner, Mr. N. G. Neill, who has been the means of promoting this enterprise and interesting Eastern capital.

PROPOSALS FOR DUST SUPPRESSION AND ROAD IMPROVEMENT.*

By Dr. Guglielminetti.

Owing to the fact that I have, on hygienic grounds, devoted my attention for about ten years past to the study of dust suppression (road-tarring), and that I am a member of the permanent International Road Commission at Paris, which has addressed itself to the practical solution of this problem —viz., the adaptation of existing roads to the new motor traffic—I have lately received several enquiries from Switzerland (among others from Colonel Pfyffer, of Lucerne, and Mr. Megevet, of Geneva) as to what is actually being done in Switzerland against the dust, the prevalence of which is undoubtedly one of the chief causes of the embitterment of the Swiss people against automobilism.

When it is remembered that even during the past excessively hot summer the residents on roads much frequented by motors were obliged to keep their windows closed all day long on account of the dust, that country seats on such roads have depreciated in value, that for a width of several yards near the dusty country roads the cattle refuse to eat the grass, that the clothes and hats of people taking a Sunday walk are spoilt, without mentioning the injurious effect upon our health of this dust as a vehicle of various disease germs—bearing all this in mind, it is not to be wondered at that the vast majority of the Swiss people are embittered against the relatively small minority of motorists. One cannot altogether blame the people, but, on the other hand, the entire blame does not rest upon the motorists.

If a motor, with its broad, absorbent rubber tyres, drives—even at a reasonable speed (30 kilometers = 19 miles per hour)—over a road covered with a layer of dust some inches thick, one must not be surprised at clouds of dust being raised. But if the same motor drives at the same speed on a well-made and well-cared-for country road on which no dust is lying, then there is no dust nuisance there; and, speaking generally, it may be said the better the road, and the more resistance the material with which it is made, the less dust there will be. Now, it would certainly cost too much to cover long stretches of road with asphalt, wood, or paving-stone, which is at present being done, as far as possible, in towns where the traffic is heavy; for country roads in several districts, however, improvement is attempted by making the roads more resistant and by watering, tarring, etc., to lay the dust on their upper surfaces.

The chief requisites for a well-kept road are good road material and a steam roller to roll the road metal in properly.

The solution of the dust problem is, therefore, more or less a question of money. Owing to the yearly increase of general traffic, and especially since the spread of motoring, the need of good roads is becoming ever more urgent in all countries, and naturally also in Switzerland, and therefore the earlier method of road maintenance is no longer sufficient.

Proposed Sources of Funds.—From whence, then, are these necessary additional expenses to be obtained? Speaking generally, it is not only motorists who benefit by well-kept roads, but also carriers, residents on the roads, etc. Good roads are ever a sign of a country's development. Via vita, it is said—i.e., The Way is Life.

Every country ought nowadays to make it a point of honor to have good roads, but every advance costs sacrifices; it is only stagnation that is cheap. An inferior gravel is cheaper than a good one, but it does not last so long; and as the result of a bad road metal everything suffers: there is excessive dust in summer, much mud in rainy weather, and carriers are obliged to reduce their loads. The same applies to the rolling: one horse can draw almost as much on a good, smooth road as two horses on a road covered for miles with loose gravel. The rolling in of the gravel by the heavy traffic is a direct pecuniary loss for every carrier, and by the end of the year it has cost the district more than it would have done to hire or purchase a steam roller. The same applies with almost equal force to road tarring; the initial outlay is greater, but the durability of the road is thereby prolonged to such an extent, and the costs of road maintenance for the period are so much reduced, that the final balance-sheet shows a saving has been effected.

Now, it is beyond all doubt that every Cantonal Government perceives the utility of good roads, yet it cannot possibly make the corresponding increase in its road budget all at once. It is, therefore, very necessary that help should be forthcoming from those whose interests are chiefly concerned. Among these I reckon first of all the motorists (foreign and native), then proprietors of hotels and restaurants, traffic unions, villa residents, all of whom will doubtless be ready and willing to furnish a financial contribution towards a better road maintenance. Motorists who—as, for example, in Aargau—are paying taxes of 10 francs only for a 30-horse power motor car, have told me that they would willingly be prepared to pay taxes up to 100 or 150 francs if these were spent on improving the roads; and such a not too excessive taxation would at once produce an additional yearly revenue of 20,000 francs (£800) for Canton Aargau. If, now, every first-class hotel would contribute, say, 1 franc per bed per annum, and the smaller hotels, say, 50 centimes, this would also yield quite a respectable amount; moreover, the occupier of a country mansion with a garden adjacent to a dusty road would perhaps be willing to spend a few hundred francs in order to be free from dust. At least this is what I have been able to accomplish in the South of France, where the hotels and traffic unions, casinos and villa owners, together with the communes, pay one-half and the State pays the other half of the cost for road-tarring, or for water-sprinkling where tarring is not practicable. This dust laying has in several French departments quite done away with the dust nuisance, and between Nice and Mentone in the height of the season there are more than a thousand motors running in a day, and yet no one complains any more of the dust, notwithstanding the long and warm period of drought on the Riviera. And now the hotel proprietors have nothing more to pay, because the tarring is paying for itself.

Money, however, is not yet everything; much must also depend on how it is spent. As in every other kind of construction, considerable progress has been achieved of late years in road making; and the problem of adapting existing roads to the new traffic at the lowest cost was the subject of two International Road Congresses—at Paris in 1908 and at Brussels in 1910—which were promoted by the French Government, largely as the result of a petition from our Dust League. To these conferences thirty-three civilized States sent their delegates, Switzerland itself, as well as several individual cantons and towns, being also officially represented.

Although it cannot be affirmed that any miraculous remedy against dust was discovered at these two congresses,

* Laid before the presidents and delegates of the Swiss Motor Club and the Traffic and Hotel Union.

yet several ways and directions were indicated, along which a nearer approach is being made towards the solution of this problem, and some general rules were laid down which can be very well adapted for every country, and therefore for our beloved Switzerland also.

A Proposed Conference.—For the purpose of obtaining an exchange of opinions on the money question—i.e., how to procure the necessary means—as well as on the cheapest and quickest method of adapting some of the greater main roads for motor traffic, according to the nature and weight of the traffic, the kind of stone, the situation and condition of these roads, etc., it appeared to me that the best way would be to have an Inter-Cantonal Conference of the Directors of Public Works, with the cantonal engineers —a conference to which those chiefly interested, motor clubs, hotel and traffic delegates should be invited, as well as the borough engineers of the larger towns.

I have for this purpose already visited the following directors of public works, Messrs. Councillor Dr. Haab (Zurich), Councillor Keller (Aargau), and Councillor Brodbeck (Liestal), and, indeed, with the presidents of the local motor sections (Messrs. Wunderli-Volkert, An-der-Auer, Bâle, and Francke, Zurlinden, Aargau) and the directors of public works, have gladly welcomed the proposal for a road conference of that kind. Dr. Haab at once declared himself ready to convene such a conference of directors, as he had formerly invited a conference of directors of justice, military affairs and finance, conditionally on his obtaining the necessary assent of his colleagues, of which, however, he felt confident. All three directors thought the moment was opportune, as an ill-wind is blowing over motor affairs in Switzerland at the present time, and there is undoubtedly a tendency to restrict the motor traffic considerably, if not prohibit it altogether. They did not conceal from us that with them the conditions are just now very unfavorable for motorists, and that as quickly as possible it must be ascertained what can be done to counteract the enormous dust nuisance, especially on certain great main roads. There would shortly be sent from the police headquarters to the respective cantons an agreement proposal on behalf of a uniform regulation as to the speed limit for motors, and the directors of public works are in great embarrassment about making such a proposal to their authorities if nothing is going to be done against the dust. Proposals have already been made, first, to debar from certain roads, and only to allow motoring on certain other roads; secondly, to permit the motor traffic only at certain times, and on Sundays, especially, to prohibit it; thirdly, specified roads within villages and communes to be regularly sprinkled with water, or to be tarred, etc. Now, if these various questions could be discussed, and also answered by the directors of public works unitedly, that would be a very welcome result.

Such a conference would afford an opportunity for an exchange of opinions on the possibility of selecting some of the greater through roads and giving special attention to those places thereon which suffer most from dust. In this way the Zurich Motor Club, for example, has already assisted some villages and communes in procuring water-sprinkling casks, and the Cantonal Government of Aargau has also placed steam rollers and tar-machines at the disposal of the communes. It should not matter in which cantons these dusty districts be; indeed, even the cantonal roads nowadays no longer serve only for intercommunication between different places in one canton, but are becoming more and more through roads. A foreign motorist no longer asks in which canton he is; if he is driving on a bad road, he simply says: "The roads in Switzerland are bad." It may be said, too, that the Aargau roads serve not only the Aargau man, but also the Zürich, Berne, or Bâle man who drives through Aargau. It is, therefore, very desirable that there should be a maintenance centre for individual through roads, and it is perhaps possible that the Traffic Office proposed by Mr. Seiler, member of the National Council or Parliament, would form such a centralization of the voluntary contributions for roads improvement.

At a conference such as that suggested above the cantonal engineers would perhaps ascertain which road metal comes cheapest, whether slag (Flusschotter), at 6 francs the cubic metre, or Swiss basalt, at 28 francs; why road tarring is very successful in the cantons of Bâle, Vaud, and Geneva, and less successful in the cantons of Zürich, Lucerne, etc.; how large a traffic must be to make it more economical to replace the road metal by stone paving or asphalte; if it would not be more advisable to hire steam rollers instead of purchasing them. These and several other questions of the kind might be dealt with.

If by means of such a road tribunal a solution of these burning questions could be found which should satisfy residents on the roads, as well as frequenters and users of these roads, a great advance would thereby have been made, and the best proof would be given to the Swiss people that the motorists intend to make good, as far as is in their power, any damage done by them, and we hope that in the general interest those on the other side will then meet the new traffic with somewhat less of antipathy.

APPROXIMATE QUANTITIES FOR TIMBER RAILWAY BRIDGES.

In the March issue of the Manitoba Engineer, a new technical magazine published by the University of Manitoba, appears an article by A. J. Taunton, giving approximate quantities for timber railway bridges. Mr. Taunton says that these figures refer to bridges on the C.N.R., and must be modified to suit other structures. For pile trestles the piles may be estimated directly from the profile, the deck and caps running at about 2,700 f.b.m. per opening of 14 ft. 9 in., and a small allowance for dump plank and bracing depending on the height being made. Allow for lengths of pile in ordinary soil 15 feet more than the height from ground to cut-off. The iron will be about 60 lbs. per M. The piling on frame trestles is also obtained from the profile. The f.b.m. timber may be approximately obtained by multiplying the area of the opening between end bents, the ground, and the base of rail by a factor K, the value of which may vary from 11 to 13½. For long low trestles K may be as high as 13½, and for short deep ones the low limit (11) will be reached. The ratios of the area of the toe slopes at the ends to the whole area, and the timber in the deck to the total quantity, will considerably influence the value of K. Good guessing on the part of the estimator is necessary; thus, combined with experience and judgment, should give very fair approximate results. The iron will be 57 to 60 lbs. per M.

The following figures are for Howe trusses, exclusive of falsework:—

Span in feet	Equivalent D.G.S. Loading	f.b.m. Timber	lbs. Iron
60	Class III.	33,000	13,000
60	" Heavy ...	42,000	28,000
80	" III. ...	56,000	40.000
120	" II.	....	58.000

(Steel angle blocks used.).

STRAIN MEASUREMENTS OF BRICK PAVEMENTS.*

By James E. Howard.†

A material of superior properties for street pavements is present in the vitrified paving brick of current manufacture. Such excellent qualities have been reached that attention is necessarily attracted by this valuable clay product. The manufacturers of paving brick have done their part in a commendable manner and produced a paving material which has a crushing strength comparing well with strong natural stone, and which exceeds that of many varieties.

A well made paving brick possesses high resistance against abrasion, it is nearly impervious to moisture, in which respect it presents an important sanitary advantage, and furthermore it is attractive in appearance and beautifies a city where it is used.

The mechanical features of manufacture are under such control that regularity of form is secured and with that follows the opportunity of securing a pavement with an even surface, a feature of decided economic importance considering its bearing on the tractive force required for transportation purposes. The necessary material for manufacture seems favorably distributed in many States. From the manufacturing end the problem of producing a satisfactory paving material has been well solved.

The question now appears to be an engineering one to ascertain the manner in which the useful properties of paving brick can best be availed of. The engineering side of the question, however, is a broad one directly concerning the welfare of many communities.

The Bureau of Standards in the performance of its regular functions pertaining to investigate tests of structural materials has inaugurated tests on paving brick in place in the pavements. Laboratory tests on the properties of brick have been carefully made many times and in many places, the results of which are familiar to all. The present tests are intended to extend information to the behavior of the brick as found under service conditions, measuring the strains which are developed in the pavements themselves and from the deformations judge of the stresses or loads which are involved.

Conditions in a pavement are complicated, and in approaching the subject it is essential to make a careful analysis of the case, ascertain and define what the elementary features consist of and so shape the work that one feature after another may be taken up and investigated. Notwithstanding the apparent complexity of the subject it nevertheless admits of being resolved into elementary factors and each in sequence made the object of experimental inquiry.

Some preliminary work was done a year ago at Indianapolis. It has since been extended at Cleveland, during which the bureau has had the co-operation and aid of Mr. Will P. Blair, secretary, and other members of the National Paving Brick Manufacturers' Association, also officials of the cities of Cleveland, East Cleveland and Lakewood.

The work in those cities has been directed toward acquiring data upon the relations of the street car tracks to the pavement and upon the effect of variations in temperature in stressing the pavement. These questions are quite distinct from those which relate to the supporting capacity of pavements against heavy wheel loads, or durability in the matter of wear or surface abrasion. So many streets furnish successful examples of pavements which have carried heavy traffic for a term of years that it was not thought necessary to include such observations at this time.

The tests on the relations of the street car tracks to the pavements consisted of measuring the elastic depression of the track under the weights of cars and acquiring information on its influence on the adjacent pavement. The elastic depressions of the rails were measured on different types of tracks, selecting among the number places where maximum rigidity was likely to prevail.

In general it was found that the vertical elastic movement of street car tracks, that is the difference in level of the rails between a loaded and an unloaded state is greater than can be followed by a monolithic pavement without the formation of cracks alongside the track. Occasionally track in the very best condition may not display excessive depression, but the uncertainty of maintaining such a state renders it hazardous to make a bond between the pavement and the track.

There is in addition to the momentary elastic depression a bodily settlement of the track resulting from insufficient support of the roadbed. Such settlement, when it occurs, involves a permanent depression altogether too great to consider in connection with those lesser movements which we are now describing. The bodily settlement of the car track, however, is a feature which cannot be left unmentioned. Cases are so flagrant at times that a good pavement can hardly be made use of by reason of the ruts of the trolley tracks.

In these tests the sensitive leveling apparatus employed in the observations was such that the presence of a trolley car could be detected by the depression which is caused even in the pavement at a distance of ten feet from the track in the direction of the sidewalk. Such an observation was made on a relaid pavement in which a tar filler had been used, and substantially at that distance with a cement filler, or from 10 to 12 feet away.

At the intersection of two streets, where no trolley tracks were present, the depression caused by the weight of a man was detected at a distance of 12 feet. This observation was made at a place where the hollow rumbling sounds of passing vehicles indicated the pavement did not rest upon the sand cushion or foundation. It was noticed that the pavement at the crown of the street responded more promptly in respect to change of level to a load coming upon it from the side rather than along the centre line of the street.

Pavements are elastic as the properties of the individual brick and the cement filler would indicate, but the amount of transverse bending which a brick or a cement grouted pavement will endure without cracking is very limited in its extent. This is particularly the case when the material is strained in tension. A wider elastic range prevails for compression loads, substantially in the ratio of the compressive to the tensile strength, or from ten to one or more.

Concerning the effects of changes in temperature on the integrity of pavements, data were acquired by the method of strain measurements, a description of which method was presented at your last annual meeting. Gauged lengths of 20 inches each were established in the pavement, in number exceeding 300. It has been found feasible to measure these gauged lengths with an accuracy, commonly to the nearest ten-thousandth of an inch. In this manner thermal changes may be followed very closely.

* Abstract of paper delivered to the twenty-sixth annual convention of the National Brick Manufacturers' Association, March 4 to 9, 1912.

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Gauged lengths were located at the sides and at the middle of the street, in both crosswise and longitudinal directions. During the time in which these strain measurements have been in progress a range of pavement temperatures of 66 degrees F. has been experienced.

In general the expansions or contractions of the crosswise gauged lengths proceeded with greater regularity than the longitudinal movements. Modifying conditions influenced the longitudinal movements and a drop in temperature yielded results which showed normal contraction on some gauged lengths, on others a very slight change, while certain of the measured lengths, those spanning cracks in the pavement, were longer at the lower temperatures.

It was found that transverse cracks which open with a drop in temperature do not always entirely close again, but displayed a tendency to progressively increase in width. Probably that was due to fine particles of sand and abraded material of the pavement lodging in the open fissures. A repetition of the process caused a progressive lengthening of the pavement. During a period of 52 days one set of measurements showed the combined effect of decrease in temperature and progressive increase in width of crack amounted to .0395, practically four hundredths of an inch. This occurred on a pavement which had been laid about four months. The crosswise gauged lengths on the same street and during the same period of time contracted regularly with, lowering of temperature, the maximum amount observed being .0039.

A number of earlier determinations on the coefficient of expansion of building brick gave a value in the vicinity of .0000040 per degree F. This value seems to fit the present tests fairly well. The observed changes were somewhat less than called for by the above value of the coefficient, but the actual range in temperature of the brick was not ascertained with precision. Surface temperatures of the brickwork were used, and not unlikely the range in mean temperature was less than the recorded amount.

Taking the observations as they were made, the contraction of the 40-ft. roadway of Euclid Avenue, for a range in temperature of 100 degrees F. was 0.1043 and 0.1101 respectively at two sections of the roadway. The contraction called for on the basis of the above mentioned value of the coefficient would be 0.1920. That is the total amount, one-half of which might be considered as affecting each side.

During sunny days the temperature of the pavement naturally goes considerably higher than the temperature of the air a few feet above it. Observations on this feature showed a difference of 38 degrees on one occasion. The temperature of the air was, on the day in question, 64 degrees, four feet above the pavement. On the pavement in the shadow of the curb it was 69 degrees. In a freshly drilled pocket for a reference pin, on the sunny side of the street, the temperature was 85 degrees, while in the sun at the angle of the pavement and curb the thermometer rose to 102 degrees.

In the laying of a cement grouted pavement a critical period is encountered at the very outset, during which care must be exercised just as in every cement structure, in order to avoid the formation of incipient cracks before the cement grout has had time to set and acquire strength. On account of the excess of water used in making grout the setting is much retarded and several days may elapse before a substantial degree of hardness is acquired.

During this period the pavement should remain at a constant temperature, if it were possible, day and night. A drop of 20 degrees calls for a contraction of about one-tenth of an inch in a length of 100 feet. It is a fortunate circumstance in laying a pavement when a minimum range in temperature is experienced during the first 48 to 96 hours after grouting. Incipient cracks have been developed at a very early period following the grouting, resulting in injury to the street even before it was opened to traffic. Hot, sunny days followed by cool nights are menacing to freshly grouted pavements.

Transverse cracks have been started, which ultimately extended across the street, by the influence of the end joints of the edge stones against which the pavement was laid. The usual manner of laying pavements, with joints broken in one direction only, affords favorable paths for cracks once started to extend from curb to curb.

Recently an opportunity was furnished for inspection of the streets of the city of Panama, where brick pavements, cement filled, have been laid from five to six years. The pavements were without expansion joints at the sides. There are no street car tracks in Panama.

The pavements are in very fine condition. In one place only were cracks of any kind noticed.

At Panama the temperature is quite high throughout the year, and while the nights are cool still the drop in temperature is not great. It is believed that equable thermal conditions have contriubted toward maintaining the integrity of these pavements, and that pavements in southern climates should in general be aided by the smaller range in temperatures over those experienced in northern climates.

In conclusion, the results now available point to the undesirability of bonding the pavements with street car tracks, excepting possibly those of the very best construction. Cracks parallel to and adjacent to the tracks are likely to develop if the pavement is called upon to follow the usual elastic depression of the rails. Obviously there can be no lateral thrust to the pavement if the rails are left free to depress.

The strain measurements show that transverse expansions and contractions proceed with greater regularity than longitudinal movements. A progressive change in length or creep of a portion of the pavement is due to alternate changes of temperature, open cracks being partly filled with abraded material and prevented from closing when a rise in temperature occurs.

Cautionary warning is found in the behavior of pavements which have developed transverse cracks in the early stages after grouting. At this time exposure to a wide range in temperature is undesirable.

Pavements are probably benefitted by a certain amount of compressive stress in a longitudinal direction. Transverse cracks will be kept closed so far as possible, and if the compressive stress is not excessive spalling would not be induced. The open ends of paved streets, having no buttresses to take the thrust, may be expected to develop transverse cracks.

The minimum amount of crowning necessary to turn the water is advantageous to enable the pavement to resist compressive stresses without causing rupture during spells of sudden heating. Bends and reversed curves in streets are disadvantageous to the pavements.

A superior material is provided in paving brick of current manufacture, the use of which requires careful engineering skill, and it appears that questions pertaining to the effects of temperature changes are among those which require most prominent attention.

SMOKE ABATEMENT.

THE POSSIBILITY OF ESTABLISHING A NEW STANDARD OF SMOKE EMISSION FOR FACTORY CHIMNEYS.*

By Dr. John S. Owens.

My primary object in bringing this paper before you is to suggest the basis for a discussion of the question of smoke emission standard, in the hope that some properly organized effort may be made to deal with the difficulties which have hitherto prevented the adoption of a proper standard.

I do not think that anyone will contradict me when I say that the emission of dense smoke from furnaces consuming bituminous coal is unnecessary and indicative of waste of fuel and bad furnace construction or working. It is true that there are a few special cases, such as heating brewery vats and pottery kilns, where the emission of dense smoke for short periods is by some still considered essential, but it is open to question if this opinion is justifiable. At the same time, it should be remembered that the total absence of all smoke is in practice usually impossible of attainment when the economy of manufacturing processes requires the burning of bituminous coal. An illustration of the difficulty of avoiding all smoke is provided by the large electric generating stations, where unforeseen variations of load occur, such as the increase due to a London fog, with its accompanying demand for artificial light. In such a case as this, it may be necessary to fire up fresh boilers very rapidly, and there is no known furnace which will admit of the smokeless combustion of bituminous coal, until the temperature of the combustion chamber has attained a sufficient height. Even in steady working it is practically impossible to avoid all smoke; a faint brown smoke is regarded as indicating more efficient working of boiler-furnaces than none at all. The emission of some smoke may, therefore, be regarded as inevitable.

The present position, therefore, is this: we know that dense smoke is unnecessary, and that entire absence of smoke is impossible of attainment, but we have not yet settled what, being fair and reasonable, should be permissible in the way of smoke, having regard to the improved methods of combustion which are now at the disposal of manufacturers. This is the question an answer to which is, I submit, within our reach and should be sought for.

The Public Health Act of 1875 supplies the present standard by which smoke is judged throughout the country, except in the case of a few important cities possessing special powers on the subject. In this Act it is stated that "Any chimney not being the chimney of a private dwelling-house sending forth black smoke in such quantity as to be a nuisance shall be deemed to be a nuisance liable to be dealt with summarily under the Act."

There is an alternative method provided by this Act under which proceedings can be taken in respect of fire places or furnaces in connection with factories which do not "as far as practicable consume the smoke arising from the combustible used therein." In practice, however, it has been found that this method of abating smoke is unworkable, owing to the lack of some standard defining the meaning of the words "as far as possible."

The standard "black smoke in such quantity as to be a nuisance" takes cognizance of two separate things in relation to smoke: its quality—that is, it must be black, and its amount—that is, enough to cause a nuisance; but, while these two essentials are taken into account, it is done in such a way that it would be practically impossible to prove in any particular case, either that the smoke was black, or that it was in sufficient quantities to be a nuisance. The point I wish to make is that the two essentials, kind and quantity, form part of the standard.

Since the date of the Public Health Act of 1875, sufficient improvements in the methods of burning bituminous coal have been made to call for a reconsideration of the present standard, and the adoption of a more up-to-date one, which will conform in a reasonable way with the possibilities of modern practice. It is unnecessary to deal at length with the evils attending the emission of smoke, from the point of view of the public. They have to breathe the smoke-polluted air of cities, useful energy and money have to be expended in cleaning away soot, buildings are injured and blackened, the daylight and sunshine are cut off, and in many other ways harm is done which, to a great extent, might be avoided if we had a sound, legally-enforced standard for smoke emission, based on the known results which the proper application of modern methods of combustion give. Manufacturers would then use the best methods of combustion and the most suitable appliances. The loss to the manufacturer in soot, estimated as a percentage of his fuel bill, is probably not more than ¼ to 1 per cent., and this is not great enough to induce much effort to save it. On the other hand, the loss to the public due to the injuries inflicted by smoke is certainly many times greater; hence it is more to the interest of the public than of the manufacturer to reduce smoke.

One difficulty which has always existed is that of dealing with large and small fuel consumers by means of a single standard, and this has militated against the establishment of a more rational standard than that laid down in the Public Health Act. Clearly we cannot limit a large manufacturer to the emission of the same total quantity of soot as a small one. His furnaces might be better designed, and combustion more perfect, than in the case of the small consumer, but the total quantity of soot emitted might be much greater. Such a limitation would, therefore, work unfairly against the large fuel consumer.

At first sight it would seem that the total quantity of soot emitted by any chimney would be the soundest thing to limit, since it determines the amount of pollution of the air by soot from a particular source; but on closer examination it appears that this is not really the best basis. What we are concerned with is the total pollution of the air by soot due to all chimneys in any particular neighborhood. For example, the erection of an electric generating station where large quantities of fuel are burned may, by displacing many small consumers who had previously to generate their own power, actually cause a great reduction in the amount of soot poured into the air. At the same time the total quantity of soot emitted from such a station might be many times greater than that previously emitted by any one of the smaller power units which it displaced; in spite of the fact that the combustion might be better and the amount of soot per ton of fuel burned much less.

What we may reasonably ask for is, that the best and most smokeless methods of combustion should be used. If we could, therefore, fix a sound standard which would be some measure of the efficiency of the methods and appliances used from the present point of view, it would work no hardship against the large fuel consumer.

We come, then, to the conclusion that what is wanted is a standard of efficiency of combustion from the smoke-

* Paper read before Section G of the British Association at Portsmouth.

prevention point of view. This must clearly take into account the amount of fuel burnt, and, if we could measure it, the proportion of the fuel passing out of the chimney as soot would be the ideal standard.

It is the aim of engineers to provide a definite quantity of air for each pound of coal burnt, hence the amount of soot per unit volume of flue gases would vary approximately as the amount of soot per unit weight of fuel, when the air supply is so regulated to suit the amount of fuel burnt. In such cases the measurement of smoke density would be a sound basis for comparison as to efficiency of combustion. It would also be a fair standard to fix, since it would measure the polluting power of the smoke emitted so far as soot is concerned.

I therefore suggest that the word "black" in the present standard should be altered to "smoke of a density exceeding" some fixed standard. The standard should, however, also include a time of emission, and the form suggested is "smoke which exceeds a certain density (as measured in a way to be determined), and which is emitted for a period exceeding so many minutes per hour."

It is necessary next to consider the question of how the smoke is to be measured, since this is an essential part of the problem of establishing a sound standard.

We may set ourselves to measure any one of the following:—

1. Total quantity of soot emitted in a given time.
2. Weight of soot emitted as percentage of fuel burnt.
3. Density of smoke or weight of soot per unit volume of flue gases.
4. Ratio of density to a standard.
5. Color.
6. Opacity, or degree of blackness.

In addition to deciding which of these objects to aim at we must keep in view that whatever method is used, it must give reasonable accuracy and a fair basis of comparison between chimney and chimney, or with a standard; it must also be easily applied from outside the factory by a single observer.

It may be mentioned here that the standard maximum adopted by the Alkalis Act of 1906 for the emission of muriatic acid in smoke or noxious fumes is one-fifth of a grain per cubic foot.

Considering now the various methods of measurement referred to above:—

Total Soot Emitted.—This measures the amount of pollution by a particular chimney, but takes no account of the amount of fuel burnt. As stated previously, it would be unfair to limit a large fuel consumer to the same total quantity of soot as a small one, even supposing we could measure it in a practical way. Its estimation implies access to the chimney and at least two measurements—that is, density of smoke and volume of flue gases.

Percentage of Fuel Lost as Soot.—To measure the weight of soot as a percentage of fuel burnt is open to the same objections as the measurement of the total quantity, but it implies at least the measurement of density of smoke, volume of flue gases, and weight of fuel. It would be a fair basis for a standard, but is quite impracticable as a method for the use of sanitary inspectors.

Density.—A quantitative measure of the density of the smoke might be obtained by the filtration method, in which the soot from a known volume of smoke is trapped and weighed, but it would be too cumbrous for general use. Density can also be measured optically, in which cases access to the chimney or factory would be unnecessary. It would give a fair measure of efficiency of the plant, and a good basis of comparison whatever the quantity of fuel burnt or diameter of the chimney.

Color.—The measurement of the color of smoke may be dismissed as useless, since color bears no relation to quantity of soot emitted or evil done by the smoke.

Opacity.—To measure the opacity of a smoke column or its degree of blackness, which is the commonly accepted method now adopted, is worse than useless, since it is misleading, because opacity alone, unless adjusted for thickness of column, is neither a measure of the density of smoke nor of the amount of pollution of the air. The smoke from different chimneys cannot be fairly compared on this basis because of their different diameters. All smoke-charts, such as the Ringlemann or Donkin, measure the opacity in a crude way; similarly, photographic methods, by which a photograph of the smoke-column is compared with standard shades, are open to the same objections. Instruments in which smoked glass is matched to the shade of the smoke, and in which no adjustment is made for chimney diameter, are equally objectionable. In a word, all these methods are only useful to compare chimneys of similar diameter, or the smoke from the same chimney at different times; when used for general comparison they are misleading.

We are thus reduced to a measurement of smoke density as the only satisfactory basis to work on. I will, therefore, go into this method in more detail.

Suppose we can measure the weight of soot in a column of smoke 1 sq. ft. in section, and the same length as the diameter of the chimney.

Let S = weight of soot in such a column.
V = velocity of flue gases in f.p.s.
D = diameter of chimney in feet.

The weight of soot in 1 cu. ft. of smoke will be $= \frac{S}{D}$,

and the weight emitted per second—

$$\frac{\pi D^2 V S}{4 D} = \frac{\pi}{4} D V S,$$

or D V S × a constant; that is, it varies as the volume of flue gases × the weight of soot per cubic foot. The amount of soot emitted will therefore vary directly as the volume of flue gases, assuming the density to remain constant. Or if we measure only S, the amount of soot emitted will vary as S × V D. If we assume V to be a constant value, the weight of soot emitted will vary as S × D, and the density of the smoke as S ÷ D. This shows that the measurement of S alone is of little use unless an adjustment is made for D, and it must be noted that all smoke-charts now in use measure something which depends on S alone, but neglects D. It also points to the conclusion that with an adjustment for D, the measurement of S can be made to give a fair approximation of the relative weight of soot emitted or to the density of the smoke.

We can measure S indirectly on the basis of the light obstructed. For example, we may compare the degree of opacity of the smoke with a smoked glass which obstructs as much light as a smoke column of known density and thickness. Suppose, then, we take such a glass of an opacity equal to that of a column of smoke of unit thickness and standard density, we might prepare an instrument having several shades of such glass, the lightest being the standard for the smallest chimney, followed by other shades made by superimposing various thicknesses of shade 1, corresponding to various thicknesses of smoke column or chimney-diameter. We could then, by comparing the smoke at the top of a chimney with such a set, say whether or to what extent the standard was being exceeded.

Suppose, for example, the smoked glasses are numbered in the ratio of their thickness, and that No. 1 matches a smoke of density G in one-foot column, the density of smoke matching glass No. N in a column D feet thick will be $\frac{N G}{D}$; that is, the density will vary as $\frac{N}{D}$, and can be given quantitatively by calibrating shade No. 1 to correspond with a known density of smoke in a column one foot thick.

If we attempt to measure the opacity or light cut off by the smoke, we get a figure which does not bear a simple relation to the smoke density such as is borne by the thickness of the smoked glass which matches the smoke. I refer to this because attempts have been made to measure the light obstructed as a basis for comparison between smoke from different chimneys.

Assuming, then, that we can observe with fair accuracy the density of smoke by such a method as I have described, the next step is to fix a certain maximum density which must not be exceeded. This could probably be best defined as: Such a density as would, when viewed by transmitted light alone and in a layer of a certain thickness, permit to pass through it a certain percentage of the light falling on it. This might be referred to a standard density. With improvement in furnaces and appliances for the more perfect combustion of bituminous coal this standard could be altered so as to represent fairly what might be expected from the current state of knowledge and invention.

It would be necessary then to provide an instrument to enable a comparison with such a standard to be easily made. The accompanying drawing illustrates one which I have designed to meet the requirements laid down in this paper. This is in the form of a small telescope, having fixed in the optical system at a point which may be brought into the focus of both object-glass and eye-piece, a revolving eccentric disc containing a number of graduated smoked glasses arranged in cells round the centre. The glasses only fill half of each cell so that by revolving the disc, as each cell with its glass is brought successively into the axis of the telescope, the smoke may be viewed through the open half of the cell and matched to the glass in the other half. The glasses are numbered in the ratio of their thickness, and a table is provided giving the number of the glass divided by the diameter of the chimney, and thus a figure which is a measure of the density of the smoke, and can be made to read the actual weight per cubic foot of soot in the smoke if desired. This necessitates the inspector knowing the chimney diameters in his district; but these may be tabulated once for all. I have found when, in instruments for smoke measurement, the smoke is viewed through a small aperture, as is essential in order not to take in too much background, that it is impossible to get true results owing to the eye being unable to focus at the same time the object aperture and the object; so that the edges of the aperture are hazy and ill-defined. This results in the whole aperture, when small, being overlaid by a hazy film, due to its ill-defined edges, which film prevents accurate readings of the smoke shade. The same applies to the aperture containing smoked glasses for comparison.

There are many difficulties remaining which apply to all optical methods of measuring smoke, but before enumerating these it is well to remind you that we have no other means of attaining our object, since all methods requiring access to a factory or a chimney are useless from the sanitary inspector's point of view. It is easy to imagine the welcome such an inspector would get on presenting himself at the door of a factory and announcing that he had come to measure the density of the smoke from the chimney. Even assuming that he was given access to the chimney, it is unlikely that the dense smoke he had seen from outside would be permitted to continue for him to measure.

I draw attention to this so that while recognizing the difficulties in the way of applying optical methods of measurement too much weight should not be given to such difficulties, nor should the presence of drawbacks to a method prevent its use if it fulfils its purpose, and a better is not forthcoming.

Turning now to a short review of these difficulties, it is well to consider what are the factors which influence the apparent density of smoke, as given by an observation based upon its degree of blackness; these are:—

1. The true density of the smoke.
2. Diameter of chimney.
3. Background of smoke and shade it is compared with.
4. The color of the smoke particles.
5. The size of the smoke particles.
6. The amount and color of the light falling on the smoke from the observer's side.
7. The direction of the line of vision.
8. Presence or absence of wind.
9. The observer's personal factor.

There is not time to discuss each of these in detail, but I may say that 1, 2, and 3 can be dealt with satisfactorily, 4 and 5 are probably sufficiently constant not to affect results seriously, excluding exceptional cases, 6 is the most difficult to deal with, and should be allowed for in making observations, 7 can be overcome, to a great extent, by keeping the angle which the line of vision makes with the horizon fairly constant, 8 would not, as a rule, be a serious obstacle, while 9 is not, I think, of great importance.

Assuming, then, that we have decided on the method of measurement to be adopted, and on the type of standard to be fixed, the question remains, how is the standard to be arrived at? It would seem that this might be done best by the appointment of a technical committee, which would make observations over a certain period, say a year, of certain selected representative chimneys, where up-to-date and well-designed furnaces are installed, and bituminous coal is burnt. A consideration of the results of such observations, both as to smoke density and time of emission, should enable the committee to fix a fair and reasonable standard, both as to the density of the smoke, and the time during which such density should be permitted.

Time does not admit of a consideration of the reasons for and against the legal enforcement of a standard. There is not, however, much room for discussion, for the fact that a legally-enforced, if unsatisfactory, standard has existed for thirty-six years proves that a standard is necessary, and that, to be of use, it must be legally enforcable. The present standard of "black smoke in such quantity as to be a nuisance" has utterly broken down, owing to the impossibility of proving to a magistrate's satisfaction that the smoke emitted was literally black. I have tried to show that it is now possible to fix a sound and workable standard for smoke emission, and to apply it in a practicable way.

RECENT CHANGES IN STEEL WORKS.

The Canadian Bridge Company have recently purchased a large stock of shares of the Wm. P. McNeil Company, New Glasgow, Nova Scotia. Mr. K. W. Bash has been appointed vice-president and engineer, and Mr. W. McNeil is the president and manager of the new company. Extensive improvements were made to the plant during the past year resulting in a well-equipped works for the manufacture of structural steelwork and further improvements are anticipated in the near future. Other than the changes noted above, the policy of the company will remain intact.

Metallurgical Comment

T. R. LOUDON, B.A.Sc.

Correspondence and Discussion Invited

THE SCHUMACHER BRIQUETTING PROCESS.*

By Prof. Joseph W. Richards.

Fresh blast-furnace flue dust mixed with from 5 to 10 per cent. of its weight of magnesium chloride or calcium chloride solution, that is to say, with from 0.25 to 2 per cent. of its weight of magnesium chloride or calcium chloride, acquires the property of setting within a short time, from 15 to 60 min., and forming a hard cemented briquette. Alkaline solutions have no action such as described. When treated in this way the flue dust briquette sets very hard, apparently from pure excess of cementing and setting power. It is, therefore, possible to mix with the flue dust a considerable proportion of inert ore or like material, which has no setting power by this process. A particularly strongly cementing flue dust will carry as much as three times its weight of fine ore or the like, and yet produce a satisfactorily strong briquette.

The Cambria Steel Company has installed at Johnstown, Pa., a small plant consisting of two presses, with a combined capacity of 250 tons of briquettes per day. One of the presses is of the mechanical type, with hydraulic safety regulator; the other is a Ronay hydraulic press. The first makes briquettes the size of an ordinary firebrick, the latter makes briquettes cylindrical in shape, 8 in. long and 8 in. in diameter and using considerably higher pressures than the former.

As seen in operation recently, the warm flue dust from the dust catchers was stored in one hopper, while fine ore, containing from 10 to 12 per cent. of moisture, and quite cold, was stored in another hopper. A rotating feeding device formed a stream of these materials, passing it into the mixing trough with an ordinary spiral, into which at the same time was run a 30 per cent. solution of calcium chloride, the flow of which was regulated by a hand valve. The trough fed the mixture directly into the hopper of the press. The flue dust was warm, approximately at 200 deg. F.; the ore was ice cold; the solution was cold. The mixture fed to the press was just warm to the touch; the bricks going from the press were decidedly hot and steaming, and where loaded into the car they were quite hot to the touch and steamed vigorously. This heating of the mixture as soon as compressed into briquettes is a characteristic of the process, and is an index of the rapid chemical reaction taking place which results in the cementing of the material.

The flue dust carries 18 to 20 per cent. of coke, which is all carried into the mixture, the mixture being 70 of ore to 30 of flue dust. There is from 5.5 to 6 per cent. of coke in a finished briquette. The saving of this coke, 20 per cent. in weight of the flue dust used, represents sufficient value to pay for the entire cost of the briquetting of the dust.

As to physical properties, a briquette made of flue dust, tested by the author, absorbed 11.5 per cent. of its weight of water, representing 27 per cent. of voids, a very satisfactory porosity. Several hundred tons of these briquettes were already in the ordinary furnace bins, ready for use in the furnaces, and appeared to have stood carriage to that point and a drop of 10 to 20 ft., and also subsequent action of ice and snow for several weeks, without deterioration; only a few were broken, and but little dust was made.

* Abstract of paper read before the recent meeting of the American Institute of Mining Engineers.

NEW TYPE OF FURNACE.

The essential feature of the Cayley Robinson furnace, of which a demonstration was given recently in London, E.C., is the gasification of the coal in one chamber and the combustion of the gas in another. The gasification process having been started by lighting the coal in the ordinary way, a small quantity of live coke is transferred from the fire into the adjacent combustion chamber in which the gases are made to circulate centrifugally by means of a jet of steam, and in which, it is claimed, they are completely consumed without ash, smoke, or clinker. The steam is generated from water in a coil of pipes placed in the combustion chamber. No actual tests have yet been carried out with the furnace, but it is stated that over 75 per cent. of the calorific value of the fuel is utilized, and that in a kitchen stove, constructed on this system, 1 lb. of coal has achieved the same results as are usually obtained with about 8 lb. in the ordinary pattern. Experiments are now being carried out with a view to adapting the principle for use in locomotives.

EFFECT OF HEAVY LOADING AND COLD ON RAILS.*

The 4½-in. 65-lb. section of the New York Central & Hudson River Railroad, in service 8½ years in the Fourth Avenue tunnel in New York City, carried 51,000,000 tons with a loss of about ¼ in. in depth of the metal upon the head of the rail. This was an English make of rail with a heavy base and thin head. The 5-in. 80-lb. section which replaced this section was in service eight years and carried 65,000,000 tons with a loss of about ⅛ in. of metal upon the head before it was removed. The 6-in. 100-lb. New York Central section, which was rolled in 1892, and replaced the 5-in. 80-lb. section, was removed in July, 1899, carried 95,000,000 tons and is still in yard service. The loss of metal on the top of the tunnel was about twice as rapid as it was from the same tonnage.

The 6-in. 100-lb. section of rail in 1895 of 0.06 phosphorus and 0.65 in carbon on the "inbound main" from 1895 until August, 1907, carried 375,000,000 tons with a loss of about ⅛ in. in depth on the head of the rail.

The light earlier sections could carry from 60,000,000 to 75,000,000 tons before they were rough and unsuitable for passenger traffic, and when in a location where the tonnage was only 250,000 to 500,000 tons per month, would last in the track many years. The heavier sections which replaced the light ones carried much greater tonnages from the increase in the density of traffic. Their larger area of metal also gave them a capacity for greater tonnages.

The 100-lb. rails in the Fourth Avenue tunnel at the present time carry daily from 150 to 200 train movements. The tonnage per month is in some places nearly as much as the light rails were subjected to in one or two years' service.

Table 1 shows the increase in freight ton-miles from 1890 to 1900, nearly doubled, while it trebled for 1910.

It has been stated that the former rails seem to last so well due to the elimination of the poorer quality of rails by the service in the track. The older rails were cold rolled by the light wheel loads until the surface was sufficiently

* From report of Am. Railway Eng. Assoc. by Dr. P. H. Dudley.

hardened to bear the recent heavier loads without much increased abrasion. New rails of the same section and practically the same physical properties would, when subjected to heavier wheel loads, lose more of the metal by wear, before the surface was rolled as hard as the former sections, and their rate would be much faster.

Dr. Dudley states that it is not considered advisable at the present time to make the composition of the rails which are to be subjected to the present heavy wheel loads so hard that at first they will entirely resist the cold rolling effect of the passing wheels. It is better to make the physical properties of the rails such that a slight flow of the metal will take place under the various worn wheel treads which will run over the rails, and in this way the surface will accommodate itself to the average treads passing over the heads, the surface becoming gradually hard, and in a short time the flow of metal is pracitcally arrested.

In rails which are too soft the surface may be worn away by the wheel loads before it becomes sufficiently hardened for the long wear or the drivers slip on the rails, producing a layer so hard as to require their removal from the track.

The mileage shown for 1830 to 1850 had been constructed mostly with strap iron rails. The mileage for 1850 to 1870 was mostly iron rails, though about one-fifth was steel rails. The mileage for 1880 was more than one-half laid with steel rails, while in that shown for 1890, 1900 and 1910 the mileage would be mostly steel. It would have been impossible to have constructed the mileage shown for 1910 without the invention of Bessemer steel. We have in the United States about 40,000,000 tons of steel in the track, of which 2,500,000 tons are of the basic open-hearth steel.

Basic Bessemer steel and basic open-hearth steels are used abroad in Germany, England, also in Africa, and the wear on the rails under their light wheel loads, particularly on the curves, is stated to be much more rapid than desired. they do in our Northern States and Canada. They use The temperatures in those countries do not fall as low as higher carbon rails in France as a rule than we do in this country with excellent effect. Their wheel loads are also much lighter and they maintain their rotundity for a longer period than the wheels here under our heavier wheel loads and long distance runs.

One of the problems confronting the railroads to-day in those States where the temperatures fall to 20 and 40 deg. below zero is to secure a sufficiently homogeneous metal in the 33 and 36 in. wheels for the entire circumference of the tire or wheel tread to maintain its rotundity. The 36-in. wheels make 560.2 revolutions per mile, and with their static load of 5 tons, the accumulated tonnage upon the tread of the tire or wheel would amount to 2801 tons for each mile which it runs.

The locomotive drivers of 79 in. in diameter make 255.3 revolutions per mile. The Pacific type engines have static loads of 14.3 tons per driver, consequently the static load per mile run upon the metal is 3,651 tons. These figures are sufficient to show that their tonnage upon each portion of the bearing surface on the tread repeats the load for each revolution and for high speed trains with great rapidity, consequently the accumulated tonnage on the tires and wheels enlarges according to the distance run.

First, the direct one which affects the metal, decreasing its ductility, but increasing its tensile strength, elastic limits and modulus of elasticity to a slight extent and making it more sensitive to shocks.

Second, indirect effect by contraction of the metal which may set up the tensile stresses of some magnitude in the rails before the ends rend in the splice bars. The intensity of this effect on the rails is greater in countries subject to temperatures near or below zero, and subject to cold waves from the north, where the temperatures fall many degrees below zero or fall in a short time and continue cold for a few days until broken by a warm wave from a tropical climate.

The experience of the railroads in the Northern and Western States this winter is more severe than ever before. Rails which have heretofore been quite free from breakages have been rendered mor susceptible to the wheel effects of the passing trains and a larger number broken than ever before reported. Such conditions have been studied to render the rails more ductile or of greater tenacity and toughness to withstand the shock of passing wheels in temperatures of from 20 to 40 deg. below zero.

The service tests of rails of large ductility or tenacity and toughness of metal in large tonnages, scattered in many States, show during the past winter an almost entire freedom from breakages and indicate that much has already been accomplished. It is now possible from a definite chemical composition to determine what ductility or toughness may be secured when the steel is properly purified in the bath, and thus increase the factor of safety in the output of the rails.

It seems that to most engineers of maintenance of way who are not conversant fully with the actual steps of the different processes of manufacture, a specification for chemical composition and a few subsequent tests for quality would be sufficient to secure rails to withstand the present service. This is by no means the case, for it is only by a knowledge of the manufacture of the steel and its subsequent use in the track that one obtains the requisite knowledge to provide for the various conditions of service to which rails are subjected.

It is the duty of users of rail to advise the manufacturers of the type and, as far as possible, the cause of failures and breakages of rails in the tracks. The gathering of statistics of rail failures of the past few years and discussing them with the manufacturers has resulted in a co-operation to improve the quality of the output of rails.

It must be remembered that with the present wheel loads and high speeds of the train movements the time factor for reversal of the stresses under the wheels and in the wheel spacing has been materially shortened by the present schedules. The wheel loads also require stresses of large magnitude to be distributed in a shorter time than was necessary with slower speeds and lesser wheel loads.

Table 1.—Miles of Track and Tonnage.

	1830.	1840.	1850.	1860.	1870.	1880.	1890.	1900.	1910.
Miles operated exclusive of side tracks, yards and terminals	23	2,818	9,021	30,626	52,922	93,296	163,597	192,556	239,652
Miles of all tracks	....	....	....	....	....	....	190,875	258,784	349,159
Tons of freight one mile	....	....	....	....	....	....	76,207,047	141,599,159	255,528,643
Passengers one mile	....	....	....	....	....	....	11,847,785	16,039,007	33,949,936
Locomotive weights without tenders (tons)	....	....	....	....	....	....	1,265,880	2,023,702	4,271,000
Freight cars—total capacity (tons)	....	....	....	....	....	....	19,288,301	37,210,720	74,043,000

UTILIZING THE WASTE HEAT OF THE OPEN-HEARTH FURNACE.*

A. Pfoser.

While the most strenuous efforts are being made to utilize the slightest improvements in the efficiency of power plants—steam engines and gas engines—with a view to economizing fuel, and great saving is being effected in this respect by the extended employment of waste-heat plant, the question of increasing the efficiency of furnaces by utilizing their waste heat is comparatively neglected. In smelting works it is true that the waste heat is used for steam raising; but even then the gases pass away into the chimney stack at such a high temperature that the waste of heat is enormous. Apart from this, however, the utilization of the waste heat from open-hearth furnaces is a matter deserving consideration.

The gases leave the open-hearth furnace at a temperature of 600 to 700 deg. C., which entails a very great loss of heat, and considerably lowers the total efficiency of the plant. According to F. Mayer, the heat balance of the open-hearth furnace plant is approximately as follows, expressed in percentages of the total heat generated by the coal consumed:—

	Per cent.
Total net useful effect	27
Losses by radiation from furnace and producers	29
Loss of heat in the waste gases	31
Combustible matter in producer cinders	3
Loss by radiation from producer	10
	100

It is evident, therefore, that the useful effect of the whole plant could be considerably increased by an improvement in the utilization of the very high losses sustained in the waste gases; but at present, no means are available for recovering the waste heat from the gases for utilization in the furnace plant itself.

The idea which first suggests itself, namely, increasing the size of the producers so as to obtain a higher degree of preliminary heating of the gas and air, and thus utilize the heat of the waste gases more effectually, is impracticable, because the pre-heating already raises the gas and air temperatures to that of the waste gases, and therefore cannot be improved upon. Consequently, the only course open for the time being is to utilize for extraneous purposes any waste heat that is capable of being recovered, steam raising being the most important to be considered.

In utilizing the waste heat of the gases so as to lower their temperature from 600—700 to 300 deg. C., about 1¾ tons of steam, at a pressure of 146 lbs., could be raised per hour from a 34-to 35-ton open-hearth furnace, consuming 27 cwts. of coal, with a heating value of 7,200 calories. Assuming 1 lb. of coal to produce 8 lbs. of steam, and that the steam would be utilized day and night for 300 days in the year, this would correspond, in the case of the above furnace, to a saving of 4½ cwts. of coal per hour, or, with coal at 16s. per ton, to an annual saving of £1,330. This saving of coal, amounting to 16.7 per cent. of the total consumption, would amend the heat balance as follows:—

	Per cent.
Total useful effect	27+16.7=43.7
Losses by radiation from furnace and producers	29.0
Loss in waste gases	31.0−16.7=14.3
Combustible matter in producer cinders	3.0
Loss by radiation from producer	10.0
	100.0

* Iron and Coal Trades' Review.

The total efficiency of the open-hearth steel plant is thus improved to the extent of 16.7 per cent. by the provision of a waste-heat boiler.

It is essential that the furnace draft should not be interfered with in the slightest degree by the interposition of such a boiler, the production of steel being the main factor in the working of the furnace. Consequently, the chimney stack must be able to produce the same draft in the furnace as before, in spite of the frictional resistance opposed by the boiler surfaces to the passage of the gases; and the fulfilment of this condition will necessitate an increase in the height of the stack. In many cases this increase will be too great to be obtained with the existing stack, and either a new stack will have to be built, or artificial draft created. In either case, the initial outlay will be recouped in 1½ to 2 years. With artificial draft, the provision of an economizer behind the waste-heat boiler will enable the temperature of the gases to be reduced to 150—200 deg. C., thus increasing the output of steam by about 20 per cent.

METALLURGICAL INVESTIGATIONS.

The work in the Metallurgical Department of the National Physical Laboratory, London, during the last year, included a continuation of the study of the alloys of aluminium with zinc and with zinc and copper together; the metallography of steel at high temperatures; the melting point of iron; the effects of strain at high temperature; and brittleness in steel. In some tests on the inflammability of flake charcoal the material was tested under various conditions of air supply, from 5 to 62 cubic feet a minute for a cubic foot of charcoal; and it was found that spontaneous combustion occurred when the temperature reached from 96 to 110 deg. C., according to the air supply, but that at lower temperatures there was no sign of spontaneous heating. At the request of Lloyd's Register the effect of exposing the charcoal to a current of air containing 5 per cent. of sulphurous acid gas was also tried, and the very startling result was obtained that even at the ordinary temperature (18 deg. C.) spontaneous combustion occurred when the charcoal had been exposed to a current of such air for hours. These experiments show clearly the danger which is involved in using this gas for disinfecting purposes in places where charcoal is used in the walls. The behavior of decayed wood has also been studied from the point of view of spontaneous combustion, but so far as the samples yet tested are concerned this material appears markedly less inflammable than charcoal.

MINING ACCIDENTS IN ONTARIO.

A report by E. T. Corkill, provincial inspector of mines, issued by the Ontario Bureau of Mines, shows that in 1911, 49 men were killed in accidents at mines, metallurgical works and quarries regulated by the Mining Act. The number of men killed and injured is distributed as follows: Mines, 36 killed and 86 injured; metallurgical works, 9 killed and 25 injured; quarries, 4 killed.

The number of men employed at mines is approximately 9,423, so that the ratio of men killed was 3.82 per 1,000. The causes of fatalities underground were: Falls of ground, 2; shaft accidents, 8; explosive accidents, 16; miscellaneous, 7. Of the three men killed on the surface, 2 were the victims of an explosion. These figures show a marked decrease in the accidents from falls of ground and in surface casualities, but a large increase in those caused by explosives.

The following classification distributes the responsibility for the causes of the fatal mine accidents: Due to dangers inherent in the work, 10; arising out of defects in the mine workings, 10; due to fault of fellow workman, 2; due to fault of injured person, 14. Of the 86 non-fatal accidents, 12 were due to explosives. The inspector notes that the provisions of the mining regulations most frequently broken by the workmen are those referring to the use of explosives.

STRIKES DURING FEBRUARY.

The strike situation in Canada continues on the whole favorable according to the latest reports of the Department of Labor. Few disputes of importance occurred during February, the one affecting most employees being that of the cloak and garment workers in the employ of T. Eaton Company, Toronto and Montreal. About 600 employees were affected by this dispute. Altogether there were twelve strikes in existence during February affecting about 50 firms and 1,200 employees. The loss of time in working days was approximately 10,000, compared with 12,000 days lost from the same cause during January, and over 32,000 days lost in February, 1911. Eight strikes remained in existence at the close of the month.

UNIVERSITY OF TORONTO ENGINEERING ALUMNI.

There was a very successful and enthusiastic gathering at the University Club, Vancouver, B.C., on March 30th, of the Engineering Alumni of the University of Toronto, Pacific Coast branch. This branch of the society was organized in Vancouver in January last, the membership being restricted to graduates and undergraduates of the engineering faculty of the University of Toronto and the old School of Practical Science, to the number of about fifty.

Speeches from a number of prominent engineers were included in the function. Among them were Mr. James H. Kennedy, chief engineer of the Great Northern Railway, who replied to the toast of the "Old School," of which he was one of the first graduates. Mr. E. B. Hermon, the president, replied to the toast "The Engineering Profession," Mr. W. A. Clement to "The Canadian Society of Civil Engineers," Mr. R. A. Thomson to "The Canadian Mining Institute," Mr. George Haynes, city engineer of North Vancouver, to "Municipal Engineering"; Mr. A. P. Augustine to "The British Columbia Land Surveyors"; Mr. James Hartney to "The Electric Engineers"; Mr. L. E. Jones and Mr. F. T. Smith to "The University of Toronto," and Mr. K. A. MacKenzie to "The General Engineering Alumni of the University of Toronto"; Mr. F. Broadfoot to "The American Society of Civil Engineers," and Mr. J. A. Mackenzie to "The American Society of Mining Engineers"; Mr. Fyfe and Mr. Broadfoot to "Athletics."

The alumni memorialized the occasion in the University Club by presenting to the club a handsome picture of the University of Toronto, main building. Dr. Wilson, the president of the club, accepted the gift in an appropriate speech.

ENGINEERING NOTES.

Regina, Sask.—During work on the pump well several employees of the city accidentally located a water gusher A five-inch pipe was laid down and the pressure forced the liquid over the end of the pipe which was left clear of the ground. An eight-inch pipe was added, forming an extension of about eight feet above ground level, and the pressure was sufficient to cause the water to flow with some force over the top of this. An investigation will be held, and in the mean time it is hoped that an additional source of water supply has been located.

Calgary, Alta.—Construction work on a new subway under the Canadian Pacific Railway tracks has been started. This subway is on Ninth Avenue East.

Vancouver, B.C.—The architects of this city are now making plans for an exhibition of their works. The display will be composed of line and wash drawings, photographs and models, and will, in all probability, be held in the Pacific Building. Mr. N. A. Leech is president of the association.

Montreal, P.Q.—The Canadian Autobus Company have made a proposition to the city council of Montreal regarding the inauguration of a line of cars on the streets of this city.

Ottawa, Ont.—The new intake pipe was in operation on April 9th last. A decided increase in the water pressure was noticed.

Hull P.Q.—A report states that the average daily water consumption in this city is 1,800,000 gallons, and the average amount pumped about three million gallons. The difference is supposed to be due to leaks in the mains. The individual consumption of water in this city is 166.66 gallons per day.

Regina, Sask.—The Regina Engineering Society has been formed. Mr. A. J. McPherson, late city commissioner, is president of the new organization. The organization has as its members nearly every engineer in the city, and it is proposed to take steps in the near future for the formation of a provincial body. The following list of officers will form the executive of the organization until the annual meeting, which will be held in November: First vice-president, H. S. Carpenter; second vice-president, L. A. Thornton; secretary, J. A. Gibson; corresponding secretary, R. O. Wynne-Roberts; treasurer, R. M. Blackburn; librarian, E. J. Wenger.

PERSONAL.

Mr. H. L. Thompson, of Vancouver, has been appointed construction engineer for the municipality of Burnaby, B.C.

Mr. I. F. Willsie has resigned his position as city engineer for the municipality of London, Ont.

Mr. Harry F. Clayton has been appointed vice-president and general manager of the Canadian Boving Company, Limited. The head offices of this company are in Toronto.

Mr. A. J. McPherson has resigned his position as city commissioner of the city of Regina, and will consider the appointment of chairman of the new Highway Commission of Saskatchewan.

Mr. John Callaghan, of Winnipeg, Man., has been appointed chief engineer of the Pacific Great Eastern Railway and assistant to Mr. B. B. Kelliher, of the Grand Trunk Pacific.

OBITUARY.

A well known trade journalist in the person of **Mr. Ivan Macdonald** has passed away. Mr. Macdonald was the founder and for a time managing editor of "Construction," a journal that devoted its talents to the architectural element. Mr. Macdonald was a Canadian, and had been engaged in editorial work for some years. His death was due to pneumonia. He was thirty years of age.

MEETINGS.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS

The members of the above institute met in the rooms of the Engineers' Club, West 40th Street, New York City, on Wednesday evening, April 17th, to discuss the question of "Engineer Commissioners." This discussion took place after an enjoyable dinner had been served.

THE SCIENTIFIC CLUB OF WINNIPEG.

The annual meeting of the above was held in Winnipeg on Tuesday, April 2nd last. The secretaries reported that during the year 11 ordinary meetings had been held, at which 18 communications had been made. Of these, 7 belonged to the physical and chemical division of natural science, and 11 to the biological division. The following committee was elected for the ensuing session: Hon. treasurer, Prof. Parker; hon. secretaries, Prof. Vincent, A. T. Cameron; additional members of committee, Principal Bletcher, Prof. Evatt, R. T. Hodgson, Dr. Leeming, Dr. McClung and Dr. Torrance.

CENTRAL RAILWAY CLUB MEETING.

Nearly two hundred attended the annual banquet of the Central Railway and Engineers' Club at the Walker House, Toronto, April 8th. The president, Mr. James Bannon, presided. Amongst those who spoke to the various toasts were: Dean Galbraith of the University of Toronto, Ald. Alfred Maguire and President Willis Chipman of the Engineers' Club.

COMING MEETINGS.

CANADIAN INSTITUTE.—198 College Street, Toronto. Saturday Evening Lectures, 8 p.m. April 20th—"Chemical Interpretations of Vital Phenomena," illustrated. Prof. Leathes. Toronto Univerity. April. 27th—"Early Economic History of Canada," S. A. Cudmore. Toronto University. Nominations.

THE CLEVELAND ENGINEERING SOCIETY.—Special Meeting, Tuesday, April 23rd, 1912, Chamber of Commerce Bldg., Cleveland, O. "Steel and its Heat Treatment" (Illustrated), by Robt. R. Abbott, Metallurgical Engineer, The Peerless Motor Car Co. F. W. Ballard, Secretary.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary. Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan. Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Addrses P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta.; Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION —President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. V. Ross.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment. London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
4-15	Cement sidewalks, Battleford, Sask.	(P. & S.) 4-4
4-30	Tunnel sewer, Edmonton, Alta.	(S.) 4-4
4-30	Subway, Saskatoon, Sask.	(P. & S.) 4-18
4-30	Trunk sewer, Edmonton, Alta.	(S.) 4-11

(Battleford and Saskatoon plans and specifications are on file at The Canadian Engineer Office, 820 Union Bank Building, Winnipeg.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Arborg, Man., school house	May 1.	Apr. 11.	59
Bay View, N.S., lifeboat house and dwelling	Apr. 30.	Apr. 11.	60
Calgary, Alta., bridge, Strathcona	Apr. 22.	Apr. 11.	59
Calgary, Alta., concrete structures	May 1.	Mar. 28.	70
Calgary, Alta., designs for aqueduct	May 1.	Feb. 22.	70
Edmonton, Alta., tunnel sewer	Apr. 30.	Apr. 4.	72
Edmonton, Alta., trunk sewer	Apr. 30.	Apr. 11.	72
Essex, Ont., post office and customs fittings	Apr. 22.	Apr. 11.	60
Holland Island, B.C., lighthouse	Apr. 20.	Mar. 21.	60
Little Pines, Sask., school house, etc.	May. 6.	Apr. 4.	60
London, Ont., cast iron pipe		Mar. 28.	72
Macdonald, Man., grading	Apr. 24.	Apr. 11.	59
Moose Jaw, Sask., water-tube boilers, etc.	Apr. 17.	Mar. 28.	59
Muncey, Ont., alterations to Industrial School	May. 1.	Apr. 4.	60
Ottawa, Ont., steel tug	Apr. 22.	Apr. 11.	60
Ottawa, Ont., improvements to Lock 15	Apr. 26.	Apr. 11.	60
Penticton, B.C., Hydro-Electric System	Apr. 18.	Apr. 11.	72
Penticton, B.C., power station	Apr. 18.	Apr. 4.	60
Point Atkinson, B.C., concrete tower, etc.	Apr. 20.	Mar. 21.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Regina, Sask., electric supplies Sec. 1 to 5	Apr. 20.	Apr. 11.	72
Regina, Sask., electric supplies, Sec. 6 to 9	May 15.	Apr. 11.	72
Saskatoon, Sask., sewer pipe	Apr. 19.	Apr. 4.	72
Stratford, Ont., pavement	Apr. 22.	Apr. 11.	72
Sudbury, Ont., sewers, etc.	Apr. 17.	Mar. 21.	60
Swan River, Man., steel bridge	Apr. 22.	Apr. 4.	74
St. Norbet, Man., draining and grading	Apr. 23.	Apr. 11.	60
Toronto, Ont., St. Alban's Cathedral	Apr. 22.	Apr. 4.	60
Toronto, Ont., bridge construction	Apr. 23.	Apr. 11.	72
Toronto, Ont., concrete mixer	Apr. 23.	Apr. 11.	72
Toronto, Ont., circular brick sewer	Apr. 23	Apr. 11.	72
Toronto, Ont., storm overflow sewer	Apr. 23.	Apr. 11.	74
Toronto, Ont., concrete walks	Apr. 19.	Mar. 28.	60
Vancouver, B.C., pumping engine, hose wagon, etc.	May 2.	Apr. 11.	60
Winnipeg, Man., machine shop	Apr. 18.	Mar. 28.	60
Yorkton, Sask., school building	Apr. 22.	Apr. 11.	60

TENDERS.

Brandon, Man.—Tenders will be received by the City Clerk, Brandon, until noon of April 18th, 1912, for the supply of 4,000 bbls. of best quality Portland cement to be delivered f.o.b. cars, Brandon. R. E. Speakman, City Engineer.

Calgary, Alta.—Tenders will be received by A. S. Dawson, Chief Engineer, Canadian Pacific Railway, Calgary, up to noon of May 15th, 1912, for approximately 4,250,000 feet B.M. of timber, and 80,000 cubic yards of excavation. (See advertisement in Canadian Engineer.)

Fort William, Ont.—Tenders will be received by the Works Committee at the office of the City Clerk up to 15th day of May, 1912, for the complete installation, including all buildings, of a fifty-ton incinerator plant and the operation of same for a period of three months after completion. John Wilson, City Engineer. (See advertisement in Canadian Engineer.)

Guelph, Ont.—Messrs. Colwill and Tanner have been appointed architects and will start on the plans immediately for the new Dominion Linen Mill, and tenders will be called for shortly.

High River, Alta.—Tenders will be received by the Secretary-Treasurer, until 8 p.m., April 30th, 1912, for the following works:—

Contract "A"—Labor laying water mains and sewers.
" "C"—Furnishing materials for and erecting water tower.
" "D"—Furnishing C.I. water pipes and special castings.
" "E"—Furnishing fire hydrants, gate valves, etc.
" "O"—Labor on main outfall sewer.
" "S"—Furnishing sewer pipes and junctions.
" "W"—Furnishing 4,500 ft. of 12-inch wooden pipe.

Tenders will be called shortly for power house, machinery and sewage disposal works.

Plans and specifications at the office of the Engineers, Toronto and Winnipeg, and at the Town Hall, High River, Alta. R. A. Wallace, Esq., Mayor. Chipman and Power, Engineers.

Kerrisdale, B.C.—The Corporation of the Municipality of Point Grey is prepared to receive tenders up to April 29th, 1912, for the construction of outfall sewer, main sewers, laterals, manholes and other relative works in the Kerrisdale district. Particulars may be obtained from Mr. D. W. Johnston, Municipal Engineer, Municipal Hall, Kerrisdale. H. Floyd, Clerk, Municipal Council, Kerrisdale.

Moose Jaw, Sask.—Tenders will be received by the City Commissioners, until noon April 30th, 1912, for the construction of a reinforced concrete subway under the Canadian Pacific Railway Company's tracks on Eleventh Avenue. Plans, etc., at the office of the City Engineer or City Clerk, Moose Jaw. (See advt. in Canadian Engineer).

Moose Jaw, Sask.—Tenders will be received until April 24th, 1912, for the erection of a Public Library Building in Crescent Park in the city of Moose Jaw. Plans, etc., can be obtained from Messrs. Reid & MacAlpine, Architects, Howden Block, Moose Jaw. W. F. Heal, Secretary, Public Library Board, Moose Jaw.

North Vancouver, B.C.—Tenders will be received up to noon of April 22, 1912, for supplying 500 lineal feet of 16-in. steel water pipe, according to specifications prepared by the City Engineer, copies of which may be obtained at the Engineer's office, North Vancouver. George S. Hanes, City Engineer.

Ottawa, Ont.—Tenders will be received until May 10th, 1912, for widening lower entrance channel-way, Sault Ste. Marie Canal. Plans, etc., at the office of the Chief Engineer of the Department of Railways and Canals, Ottawa, and at the office of the Engineer in charge, Sault Ste. Marie, Ont., at which places form of tender may be obtained. L. K. Jones, Secretary, Department of Railways and Canals, Ottawa.

Ottawa, Ont.—Sealed proposals will be received at the Public Works Department up to the 2nd day of July, 1912, for the construction of a dry dock in the Port of Quebec. Dimensions of dry dock to be not less than 1,150-ft. usable length, 110-ft. clear width at entrance, and at least 37-ft. in depth over sill and keel blocks at ordinary high water Spring tide, and to be in three compartments. Dry dock will be located either at Lauson or in the estuary of the River St. Charles, or on the Beauport flats, and applicants will be required to submit with their proposal a report signed by their engineer or engineers setting forth in detail: (1) the respective advantages from the viewpoint of the shipping interests of each of the above-mentioned sites; (2) plans and specifications with full and detailed estimates of cost. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Separate tenders will be received at the Department of Public Works, until April 30th, 1912, for the supply of hardware, brushes, manilla rope, packing, paint and paint oil, hose, wire rope, oils and greases, steam pipe, chain and steam fittings for the departmental dredging plant. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Structural Competitive Designs for a monument to be erected at Ottawa, Canada, to His Late Majesty King Edward VII., will be received at the Department of Public Works, Ottawa, up to October 1st, 1912. Full particulars may be had on application to R. C. Desrochers, Secretary, Department of Public Works, Canada.

Ottawa, Ont.—Plans have been completed and tenders will be called shortly for the construction of a new Government steamer to be used in the customs patrol service in the Gulf of St. Lawrence. Vessel will be of steel, will have a length of 200 feet, and cost a quarter of a million dollars.

Ottawa, Ont.—Tenders will be received by G. J. Desbarats, Deputy-Minister of the Naval Service, Department of the Naval Service, up to noon of June 17th, 1912, for the design and construction of a new Fishery Protection Vessel for Service on the Pacific Coast. (See advt. in Canadian Engineer).

Ottawa, Ont.—Tenders for interior fittings, post office, at Nanaimo, B.C., will be received at the Department of Public Works, Ottawa, until April 22, 1912. Plans and specifications to be seen on application to Mr. James May, Clerk of Works, Nanaimo, B.C.; Mr. W. Henderson, Resident Architect, Victoria, B.C., and at the Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the erection of a frame schoolhouse on the St. Mary's Reserve, near Fredericton, N.B., will be received at the office of J. D. McLean, Assistant Deputy and Secretary, Department of Indian Affairs, Ottawa, up till noon of May 2nd, 1912. Plans and specifications may be seen at the office of N. J. Smith, Indian Agent, Fredericton, or at the office of the Department of Indian Affairs.

Prince Albert, Sask.—Tenders will be received by the City Commissioners up to noon of April 30th, 1912, for the construction of concrete sidewalks.

Contract 12 H.—About 3 7/10 miles.
Contract 12 J.—About 4 9/10 miles.

Specifications, etc., may be obtained at the office of the City Engineer, of Prince Albert. C. O. Davidson, Secretary-Treasurer, Prince Albert, Sask.

Regina, Sask.—Tenders will be received until Saturday, April 20th, for a three-story fire-proof building for the Engineers' and Plumbers' Supply Company, Limited. Plans and specifications can be seen at the office of N. R. Darrach, Architect, Western Trust Building, Regina.

Saskatoon, Sask.—Tenders will be received by the City Commissioners, up to noon of May 17th, 1912, for furnishing material for and construction of Superstructure 23rd Street Subway. (See Advertisement in Canadian Engineer).

Selkirk P.O., Man.—Tenders will be received until May 7th, 1912, for the building of a bridge over Gunn's Creek, on Lot 162, St. Andrews; bridge to have concrete abutments and a wood top, and to be built according to plans and specifications, which may be seen at the Municipal Office, or at the Department of Public Works, Winnipeg. Thos. Bunn, Secretary-Treasurer, Selkirk P.O., Man.

Winnipeg, Man.—Tenders will be received until April 30th, 1912, for the erection of twelve additional rooms to existing Britannia School, Hampton Street, St. James. Revised plans and specifications can be seen at the office of E. D. Tuttle, Architect, 701 McArthur Bldg., Winnipeg.

CONTRACTS AWARDED.

Calgary, Alta.—Messrs. Doyle & Thompson, 20 Elma Block, Calgary, have received contract for the erection of a school to cost $172,000.

Calgary, Alta.—The contract for the erection of the new King George school in Pleasant Heights was awarded to Jones & Lyttle for $125,620, while the heating and plumbing contract for the building was given to Grant Bros., whose figure was $21,850.

Campbellton, N.B.—Interior fittings, post office; Edward Bates, contractor, St. John, N.B.

Hamilton, Ont.—A report states that the contract for the supply of concrete poles for the hydro-electric service has been awarded to Messrs. Hancock and Sons, brick manufacturers, Hamilton.

Lansdowne Park, Ottawa, Ont.—Machinery Hall; contractors, Messrs. Alexander & Campbell, Ottawa; cost, $81,309.

Lethbridge, Alta.—Contracts for the Galbraith school and for the physical culture building to be erected in connection with the Westminster school, were let to the Lussier Construction Company; the cost of the former being $55,000, and of the latter, $5,950. The Wm. Head Company got the heating and plumbing contract for $14,000. Others tendering for the Galbraith school were: S. Stanford, $59,000; Hotson & Leader Co., $63,000; Odmark Bros., Macleod stone, $56,550, Bedford, $56,550; W. P. Bayne, Macleod, $58,109, Bedford, $57,478; W. H. Holt, Macleod, $56,800, Bedford, $57,270; Smith Bros. & Wilson, Macleod, $56,200, Bedford, $55,850. The building will be of Bedford stone.

Montreal, Que.—General contractor E. G. M. Cape, Beardmore Bldg., Montreal, has received the contract for an addition to the Sarah Maxwell School to cost $37,000. The iron work contract has been awarded to Phoenix Bridge & Iron Works, Ltd., 83 Colborne Street.

Port Arthur, Ont.—Messrs. Barnett & McQueen, Fort William, Ont., have received the contract for the construction of a steel dock for the Canadian Northern Railway, to cost $40,000. Sub-contracts for piling, etc., have been awarded to the Thunder Bay Harbor Improvement Co.

Prince Rupert, B.C.—Messrs. Evans, Coleman & Evans, of Vancouver, have the contract of supplying Prince Rupert with 3,800 feet of 18 inch diameter steel pipe.

Saskatoon, Sask.—Messrs. Fielding & Shepley, of St. Paul, Minn., have received the contract for laying of approximately 23,100 square yards of sandstone block pavement, their price being $117,810.00. Other tenderers were the Forest City Paving and Construction Company, London, Ont., at $124,740, and Messrs. Pastoret & Lawrence, Duluth, Minn., at $126,588.

Toronto, Ont.—The contract for the supply of T-rails for use on the new civic car lines to be constructed on St. Clair Avenue, has been awarded to the United States Steel Products Co., Montreal. The T-rail tender is $35,996, 80 pounds to the foot, and the girder rail tender for 90-pound rails is $43,195. Other contracts for bars, etc., go to the Rail Joint Co. of Canada.

Vancouver, B.C.—Tenders received for the widening of the approaches to the Main Street bridge were: Messrs. McKenzie, Broadfoot & Co., $7,495; T. R. Nickson & Co., $8,635; La Placa Bros., $7,180. The last named was accepted.

Vancouver, B.C.—The contract for the construction of the south section of the Bridge Street trunk sewer has been awarded to J. Shunn, Esq., of Vancouver, for $30,158.00. Eleven other bids were received.

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Winnipeg, Man.—The Canadian Mineral Rubber Company, Winnipeg, has been awarded contract for the supply of from 1,200 to 1,500 tons of asphalt cement at $23.50 per net ton.

RAILWAYS—STEAM AND ELECTRIC.

Kingston, Ont.—A report states that the Kingston and Pembroke Railway will expend $205,000 this summer on improvements over the line.

Ottawa, Ont.—The Minister of Railways has placed an order for rolling stock to be used on the lines of the Intercolonial Railway. The sum involved is about $1,125,000. The orders include nine freight locomotives from the Canadian Locomotive Works at Kingston, 400 steel box cars from the Nova Scotia Car Company, two dining cars and two sleepers from the Canadian Foundry Company, and six first-class coaches from the Preston Car Company. In addition a number of flat cars, stock, refrigerator and coal cars are to be ordered.

Ottawa, Ont.—The management of the Ottawa Electric Street Railway Company recently placed an order with the Ottawa Car Company for twenty new steel street cars. The cars will be manufactured of steel throughout excepting the door and window frames.

South Vancouver, B.C.—The ratepayers of the Ferris Road district have prepared a petition calling for an extension of the electric car line from Main Street.

Toronto, Ont.—The municipal railway department under the management of the city engineer, Mr. Rust, has been authorized to purchase the following track supplies without tenders being called for: 6,000 steel ties, 24,000 rail clips, 24,000 tie bolts, 18,000 wood ties.

The track laying programme of the Canadian Northern Railway for this year includes the following works:—Montreal to Hawkesbury, 58 miles; Ottawa to Ottawa River, 32 miles; west from Ruel, Ont., 100 miles; east from Port Arthur, 108 miles; branch lines and extensions in Alberta and Saskatchewan, 400 miles; British Columbia, 75 miles; Sydenham, O., to Ottawa, 80 miles; relaying track on main line west, 200 miles; total, 1,053 miles.

LIGHT, HEAT AND POWER.

Niagara Falls, Ont.—The Dominion Government have decided to construct a new power house and pumping station at this point. This will remove the present plant from Table Rock and increase the efficiency of this department.

Ottawa, Ont.—The estimates for civic lighting call for cluster lights to be installed on Lady Grey Road for a distance of about two miles.

Welland, Ont.—The municipal council have passed a by-law whereby that body will offer the Welland Electrical Company the sum of $50,000.00 for their plant.

GARBAGE, SEWAGE AND WATER.

Cobourg, Ont.—A large water tank belonging to the municipality was demolished by a fall recently. It will cost about $25,000.00 to replace, but it is unlikely that such will be done.

Hull, P.Q.—The ratepayers of the Wrightville district have arranged for the installation of a new sewage system which is to be completed by June 1st, next.

Ingersoll, Ont.—Preliminary steps have been commenced for the installation of a sewerage system for this town. Mr. Chipman, C.E., Toronto, will advise the municipal council in the matter.

Ingersoll, Ont.—The ratepayers of this town will assume control of the water works after May 1st next. The price paid for the property complete was $125,000.00.

Kingston, Ont.—The municipal board of health have requested the city council to install a filtration plant for the purification of the drinking water.

St. Catharines, Ont.—The municipal council have adopted an extensive sewer construction programme which will entail the expenditure of about $25,000.

BUILDINGS AND INDUSTRIAL WORKS.

Barrie, Ont.—The municipal board of education are planning to erect a new collegiate building. The plans as submitted to the members call for an expenditure of approximately $65,000.00.

Guelph, Ont.—Plans for a factory of the Dominion Linen Mills have been prepared. They call for the construction of four buildings of pressed brick and steel sash. The main building will be 380 x 150 with 30 foot windows.

Mildmay, Ont.—The Roman Catholics of this place are about to construct a new church. Mildmay is near Stratford, Ont.

Montreal, P.Q.—The Montreal Association for the blind are erecting a handsome school building in this city.

Regina, Sask.—The Roman Catholics of this city are planning to erect a new cathedral. Bishop Mathieu is taking charge of the preliminaries.

Regina, Sask.—Plans have been prepared for the new Grand Trunk Pacific station at this point. It will be two stories in height, 600 x 250 including the train sheds.

Roche Percee, Sask.—A brick manufacturing concern has been organized to operate in the vicinity of this place. The promoters plan a $30,000 plant with a daily capacity of 40,000 brick. Mr. G. T. Cross, manager of the City Ice and Coal Company, Moose Jaw, Sask., is the president of the new company.

Saskatoon, Sask.—The Board of Education have called tenders to be in by April 25th next for the erection of a new school in the district of Westmount.

Smith's Falls, Ont.—The management of the Canadian Northern Railway will erect a new railroad station in this town.

Toronto, Ont.—A syndicate will erect a five story building at the corner of Bay and Queen Streets. Sir Richard Cartwright is the head of this syndicate.

Vancouver, B.C.—The management of the Molsons Bank are about to erect a handsome branch office in this city. H. L. Stevens and Company, Architectural Engineers, are preparing the plans. It will be of brick six stories in height.

Vancouver, B.C.—The congregation of Trinity Church (Anglican), have decided to erect a new church structure. The rector, Rev. H. Beecham, will appoint a committee to handle the matter.

BRIDGES, ROADS AND PAVEMENTS.

Carleton County, Ont.—The officials of this county have recently given serious consideration to the matter of good roads and repairs to the ones now in use. The council expressed their opinion on the necessity of the purchase of three or four road machines, but no definite action has, as yet been taken. Mr. A. P. Wilson, Osgoode, Ont., is interested in the matter.

Central Ontario.—Reports from Barrie, Ont., of the damage to country bridges from the flood indicate that the loss will amount to about $50,000. A special meeting of the Simcoe County Council will be held to discuss the situation. Five bridges on the Nottawasaga and Boyne Rivers are completely demolished.

Guelph, Ont.—The municipal council have decided to erect a bridge over the river and the Canadian Pacific Railway tracks at Hefferman Street. It will be a foot bridge.

Lower Ontario.—Several bridges along the road of the Canadian Pacific Railway will require considerable repair work following the damage caused by the recent floods. The trains of this company will operate on the lines of the Grand Trunk between Toronto and North Bay during the next few weeks.

Montreal, P.Q.—The municipal council have taken definite steps towards the construction of a subway below the Canadian Pacific Railway tracks on Park Avenue. The structure is to cost between $250,000 and $400,000. The Railway Board will consider the matter at their sitting in Montreal on April 22nd.

Victoria, B.C.—Arrangements are being made for a conference between the Minister of Public Works and several municipalities in this neighborhood to discuss the question of paving the main highway between Vancouver and New Westminster.

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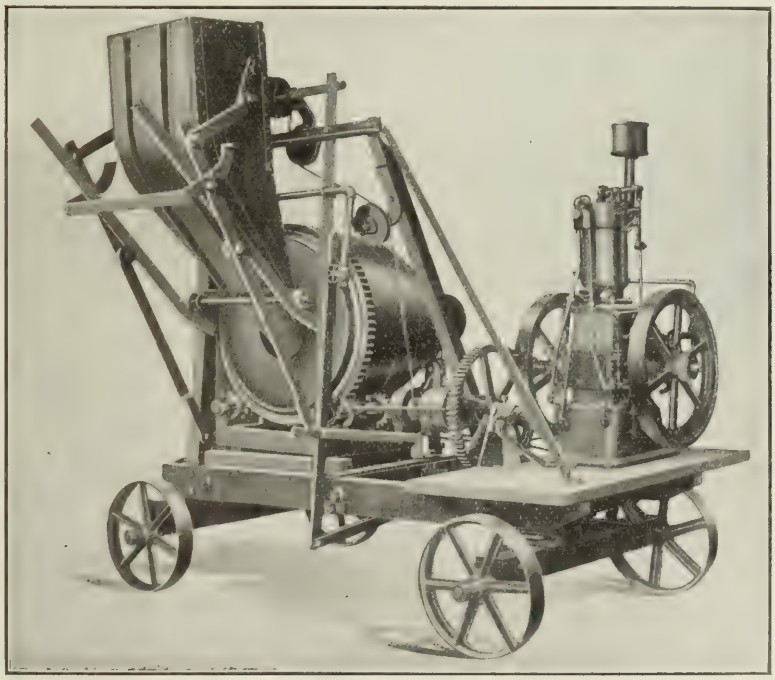

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Victoria, B.C.—The Municipal Streets Committee have ordered the construction of a new bridge across the ravine of the Gore Road. The City Engineer recommends a reinforced concrete structure at a cost of $24,371. The chairman of the committee, Alderman Stewart, will co-operate with the engineer on the selection of this bridge or a steel structure to cost $32,300.

FIRES.

Fort William, Ont.—A large rink was destroyed by fire in this city recently; the loss is placed at $35,000. The structure was known as the Arena.

Montreal, P.Q.—Fire caused considerable damage to part of the plant of the Caledonian Iron Works. The damage was confined to the moulding shop.

CURRENT NEWS.

Edmonton, Alta.—Recent tests of the new high pressure pumps of the city resulted in a satisfactory report being made by the fire chief.

Ingersoll, Ont.—An inspection of the various dams in the vicinity of this town will be made following an order from the mayor's office.

Lethbridge, Alta.—There is an active movement among the members of the Municipal Board of Trade calling for gas boring operations to be commenced. Some time back the sum of $30,000 was laid aside for this purpose, and of this about $16,000 was spent in an unsuccessful attempt to locate this utility. Several encouraging reports are now to hand and it is on the strength of these that the renewed activities are being undertaken.

Vancouver, B.C.—A new telegraph line will be constructed from this city to Powell River. This line will cost $27,400, and will be installed by the Federal Government.

TRADE ENQUIRIES.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.

A London company would like to get into touch with a reliable firm of engineers in Canada who could introduce and sell their oil extraction plant.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16192—March 29—Authorizing C.N.O. Ry. to cross Sydenham Lake, in Twp. of Loughborough, Ct. Frontenac, and rescinding Order No. 15026 of Oct. 10th, 1911.

16193—March 26—Approving revised location of Algoma Central & H.H. Ry. between mileage 123.74 to 130.87 and connection with N.T.R. at Grant, Ont.

16194—March 28—Authorizing Department of Public Works, B.C., to cross with Park Ave., C.P.R. in Slocan City, B.C.

16195-96—March 28—Authorizing C.P.R. to construct additional track across highways at Basswood and Birtle, Manitoba.

16197—October 9—Authorizing C.P.R. to divert highway at mileage 119.7 on its Medicine Hat Subdivision, Alberta.

16198—March 29—Authorizing V.V. & E. Ry. & N. Co. to construct crossings in Mun. of Sumas, B.C.

16199—March 8—Authorizing G.T.R. to take lands of Samuel McLean, part of Lot 13, R. 1, south of Longwood's Road, Twp. of Ekfrid, County of Middlesex, Ontario.

16200—April 1—Authorizing M.C.R. to use and operate bridge over Bear Creek, at mileage 57.3 St. Clair Division.

16201—March 29—Authorizing G.T.P. Ry. to construct spur for Imperial Oil Company, Ltd., Edmonton, Alta.

16202—March 30—Authorizing G.T.R. to reconstruct bridge No. 50, at mileage 7.47 8th District, Northern Division.

16203—March 30—Authorizing C.P.R. to reconstruct bridge No. 95.8 across Muskrat River, Chalk River Subdivision, Ont.

16204—March 30—Authorizing C.P.R. to construct spur for A. F. Vincent, near Mile End Station, Montreal, Que.

16205—March 21—Authorizing C.N.O. Railway to construct transfer track to connect its Sudbury Branch with Algoma Eastern Ry. through town of Sudbury, Ontario.

16206—March 30—16207—April 1—Approving location of C.N.R. (Calgary-Strathcona Line) through Twp. 40, R. 26, west 4 M., Alberta. Mileage 0.00 to 4.55 and C.N.R. location through 14-9, Ranges 26 and 25, west 4th M., Alberta. Mileage 65.05 to 102.50.

16208—March 30—Dismissing complaint of C. W. Deaver, Viscount, Sask., re cattle pass on G.T.P. Rly.

16209—April 1—Approving location of C.P.R. station at Lydiatt, Manitoba.

16210—March 30—Dismissing complaint of residents of village of Brownlee, Sask., re C.P.R. car supply.

16211—April 1—Authorizing C.P.R. to open for carriage of traffic (freight) its railway from Colvalli to Bull River a distance of 9.2 miles (Kootenay Central Ry.)

16212-13-14—April 1—Authorizing C.P.R. to construct spur for Dominion Match Co., Ltd., Dist. of New Westminster, B.C. For the Sudbury Construction and Machinery Co., Ltd., in town of Sudbury, Ont. For the Canadian Hanson and Van Winkle Co., Ltd., near Morrow Avenue, Toronto, Ont.

16215—March 30—Authorizing C.N.R. to cross Calgary and Edmonton trail, Bailey, Barnett, and Oliver Avenue and Matthias Street, and to close certain lands in town of Lacombe, Alta.

16216—March 30—Authorizing G.T.R. to reconstruct bridge across "Narrows" at mile-post 120.39, 9th Dist. Nor. Div., Ont.

16217—April 2—Authorizing C.P.R. to reconstruct bridge 81.0 on its Sudbury Division.

16218—April 2—Approving revised location of C.P.R., Wilkie, Anglia Branch from Pheasant Hills Branch, in Sec. 6, Twp. 40, R. 19, west 3rd, for a distance of 35.34 miles to a point in Sec. 22, Twp. 34, R. 19, W. 3 M., Sask.

16219—April 2—16220-21—April 1—C.N.O. Rly. Co. (Sudbury Port Arthur Line), approving location through unsurveyed territory, Dist. of Thunder Bay, mileage 343.15 to 363 from Sudbury Jct., and revised location through unsurveyed territory in Dist. of Algoma, mileage 209.1 to 219.43 from Sudbury Jct., and C.N.O. Ry. (Montreal-Port Arthur Line), through unsurveyed territory (revised location), Dist. of Sudbury, mileage 270.9 to 272.83.

16222—April 2—Approving location of C.N.O. Ry. (Calgary-Strathcona Branch through Twps. 47-52, R. 24-26, west 4 M., and part of city of Strathcona, Alberta.

16223—April 3—Approving Standard Passenger Tariff C.R.C. No. 3, of Klondike Mines Railway Company.

16224—April 3—Authorizing C.P.R. to construct its Moose Jaw Southwesterly Branch across 4 highways, mileage 23.22 to 36.65.

16225—April 3—Directing that local tolls of Vancouver, Fraser Valley & Southern Rly. Co., on lumber, etc., shall be same as charged by C.P.R. and G.N.R. for similar distance within their corresponding territories, and directing that joint through rates on lumber to be on basis of one cent per 100 pounds, etc.

16226-27-28—April 3—Disallowing increased tolls of G.T.P., C.N.R., and C.P.R. from 1st day of April, 1912, and restoring lower tolls in effect immediately before that date being rates from Westfort, Port Arthur, Fort William.

16229—April 4—Extending until 1st Oct., 1912, time for completion of C.N.R. spur authorized by Order 15322, March 29, 1911, in city of St. Boniface, Man.

16230—April 4—Extending for 6 months from 30 March, 1912, time for completion of extension of A.C. & H.B. Ry. to Bruce Street, Sault Ste. Marie, Ontario.

16231—April 3—Granting certificate of correction to G.T.P. B.L. Co., for errors in Regina-Moose Jaw Branch location plan.

16232—March 25—Approving location of C.P.R. station at Griffin, Sask.

16233—April 8—Approving Order of Exchequer Court of Canada appointing Frank W. Blair, Dudley E. Waters, and Newman Erb, Receivers of the Pere Marquette R.R. Co., in Canada.

16234—March 11—Rescinding Order 16004 of February 15th, 1912, and authorizing C.N.R. to cross C.P.R. at Lambton, by means of an undercrossing, Twp. of Etobicoke, County York, Ont.

16235—April 1—Amending Order No. 15558, of Dec. 5, 1911, by adding clause directing city of Winnipeg to reimburse .P.R. for services of flagman, etc., at crossing.

16236—April 3—Authorizing Lachine, Jacques Cartier & Maisonneuve Rly. Co. (G.T.R.) to cross Montreal Street Railway by means of overhead bridges at three streets in Montreal.

16237—April 1—Directing that C.N.R. and C.P.R. protect crossing on Main Street, Gladstone, Man., by watchman.

16238—April 1—Directing G.T.P. Ry. to grade a new crossing parallel with Main St., and open Beaver Hills Road across its right-of-way in village of Ituna, Sask.

16239—April 2—Dismissing application of residents in vicinity of Carrot Creek, Alta., re G.T.P. siding.

16240—April 1—Refusing application of farmers in vicinity of Pleasant Point, near Carberry, Man., for an order directing C.P.R. to construct a siding.

16241—April 1—Directing C.N.R. to fence its right-of-way along the Qu'Appelle, Long Lake & Sask. Rv., between Saskatoon and Regina, that is now unfenced, under penalty of $50 per day after 1st Nov., 1912.

16242—April 2—Directing G.T.P. to cease discriminating in carriage of freight traffic in favor of its contracts as against general public over its line from Hinton, Alta., to west thereof; subject to fine of $100. Petition of towns in B.C. and Alta.

16243—April 6—Authorizing C.N.O. Ry. to cross four highways in Twp. of Nepean, Carleton County, Ontario.

16244—April 6—Authorizing C.N.R. to cross with its Calgary-Edmonton Branch 6 highways in Alberta.

16245—April 1—Authorizing C.N.R. to construct spur to city of Saskatoon Power House, Saskatoon, Sask.

16246—April 3—Authorizing C.N.R. to cross 5 highways in city of Strathcona, Alta.

16247-48—April 4—Approving location of Campbellford, Lake Ontario & Western Rv. (C.P.R.) Glen Tay to Belleville Branch Line from mileage 15, across Twps. of Oso, Bedford, and Hinchinbrooke, crossing K. & P. Ry. near Parham station to westerly boundary of Twp. of Hinchinbrooke, at mileage 38.5, Ct. Frontenac, Ont. And location of Glen Tay to Cobourg Line from mileage 38.5 to mileage 58.5 in United Counties of Lennox and Addington.

16249—April 4—16250—April 6—Authorizing G.T.P. Ry. to construct bridge across Fraser River at mileage 316 and 274 west of Wolf Creek, B.C.

16251—April 2—Refusing application of G.T.P. B.L. Co. re right-of-way Tofield-Calgary Branch.

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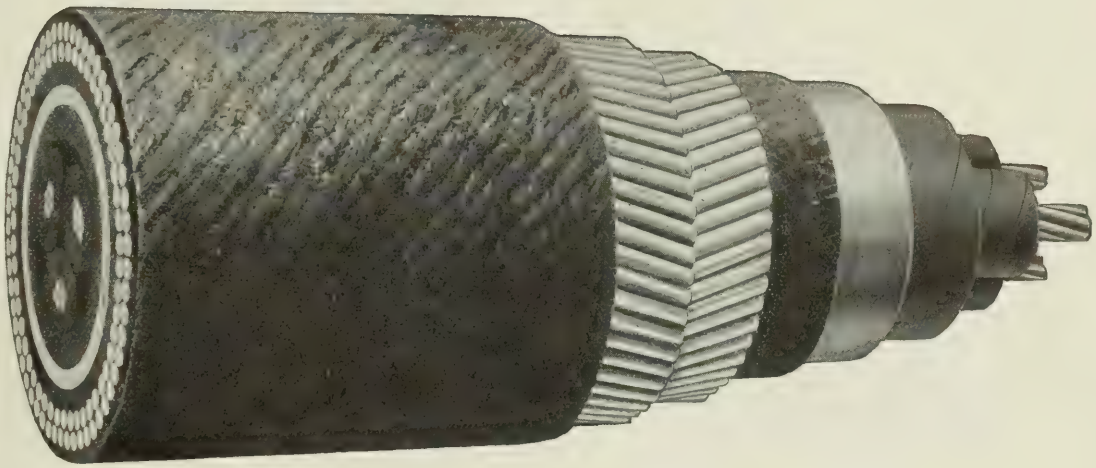

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HEAD OFFICE - MONTREAL

16252—April 3—Authorizing G.T.B. B.L. Co. to cross the Brandon Branch of the C.P.R. by overhead bridge in N.W. ¼ of Sec. 26, Twp. 10, Range 18, west P.M., Man.

16253-54—April 2—Authorizing C.P.R. to take lands for construction of permanent snow fences in Twp. of Pickering, Ct. Ontario, Ont.

16255—April 4—Relieving C.P.R. from erecting and maintaining fences on portion of its Calgary Subdivision, Alta.

16256-57—April 6—Authorizing G.T.P. B.L. Co. to cross with its Calgary Boundary Branch the C.P.R. Aldersyde Branch in N.E. ¼ of Sec. 4, Twp. 12, R. 23, west 4th M., and in N.W. ¼ of Sec. 26, Twp. 19, Range 28, west 4th M. Interlocking plants to be installed at the two crossings.

16258—April 6—Authorizing G.T.P. B.L. Co. to construct, maintain and operate "wye" connecting its Alberta Coal Branch with Yellowhead Pass Coal & Coke Co.'s Spur, Alberta.

16259—April 9—Rescinding Order 8462, Oct. 29th, 1909, and directing the G.T.P. to construct an overhead crossing on the Fort Saskatchewan Trail; detail plans to be filed within 30 days, and work to be completed within ninety days from approval of plans under penalty of $100 per day, North Edmonton, Alta.

16260—April 10—Authorizing C.P.R. to construct spur for Chinook Coal Company, Ltd., at Kipp, in the Province of Alberta, and rescinding Order 16088, of March 7th, 1912.

16261—April 9—Authorizing G.T.R. to construct spur into premises of Western Foundry Co., Ltd., town of Wingham, Ontario.

16262-63-64—April 9—Authorizing C.P.R. to reconstruct bridge No. 22.5 on its Newport Subdivision; bridge 32.6 on its Ottawa Subdivision; and bridges 24.8, 30.7, 32.2, and 35.8 on its Farnham Subdivision.

16265—April 9—Authorizing C.P.R. to construct its Moose Jaw Southwesterly Branch across highway at mileage 36.63.

16266—April 10—Approving revised location of C.N.O. Ry. in the Twp. of Litchfield, mileage 59.13 to 59.73 from Ottawa, Ont.

16267—April 10—Approving location of C.N.R. Co. (Montreal-Port Arthur Line) through Twps of MacTennan, Scadding, Street and Davis, in Dist. of Sudbury, mileage 405.36 to 421.09 from Montreal.

16268—April 10—Authorizing C.N.O. Ry. to connect its tracks with C.P.R. at mileage 2, in Port Arthur, only, for construction purposes only.

16269—April 9—Authorizing C.N.R. to construct its Calgary-Strathcona line across 25 highways in Alberta.

PUBLIC SERVICE OF CANADIAN RAILWAYS.

During the year ended June 30, 1911, there were carried by the railways of Canada 37,097,718 passengers and 79,884,282 tons of freight. These figures show an increase over the preceding year of 1,203,143 passengers and 5,401,416 tons of freight.

The following table shows the number of passengers carried for various periods:—

	Passengers carried.
1875	5,190,416
1890	12,821,262
1894	14,462,498
1901	18,385,722
1908	34,044,992
1909	32,683,309
1910	35,894,575
1911	37,097,718

The freight record for the same periods was as follows:—

	Tons of freight 2,000 lbs.
1875	5,670,837
1890	20,787,469
1894	20,721,116
1901	36,999,371
1908	63,071,167
1909	66,842,258
1910	74,482,866
1911	79,884,282

In 1875 the number of passengers and tons of freight carried were nearly equal. Thereafter, the development of freight traffic proceeded more rapidly than did the development of passenger business.

The number of passengers carried in 1911 was 37,097,718—an increase of 3.3 per cent. over 1910. The number of passengers carried one mile was 2,605,968,924, representing an increase of 139,239,260 as compared with the preceding year. The density of passenger traffic—as represented in the number of passengers carried one mile per mile of line—was 102,597. These figures show a gain of 2,855 over 1910. The increase since 1907 has been 11,676.

The following is an interesting table:—

	1910.	1911.
Tons hauled	74,482,866	79,884,282
Tons hauled one mile	15,712,127,701	16,048,478,295
Tons hauled one mile per mile of line	635,321	631,829
Average haul, miles	211	200
Freight train mileage	50,184,108	52,498,866
Mixed train mileage	6,441,440	6,277,468
Revenue from freight	$116,229,894	$124,743,015
Average tons per train	311	305
Average cars per train	18.15	18.03
Average tons per car	17.13	16.91
Average receipts per ton per mile, cent.	.739	.777

The following is an analysis of the commodities which constituted the freight traffic of 1911 and the preceding year:—

	1910. Tons.	1911. Tons.
Products of agriculture—		
Grain	7,435,573	7,545,516
Flour	1,916,934	2,124,080
Other mill products	1,037,282	1,166,323
Hay	1,084,966	1,611,621
Tobacco	40,880	51,672
Cotton	84,928	114,827
Fruit and vegetables	969,122	957,237
Other products of agriculture	321,666	238,260
Products of animals—		
Live stock	1,314,781	1,437,965
Dressed meats	546,791	561,220
Other packing house products	277,739	369,906
Poultry, game and fish	154,820	189,201
Wool	28,814	42,602
Hides and leather	199,853	211,301
Other products of animals	242,208	378,507
Products of mines:		
Anthracite coal	7,498,509	6,017,858
Bituminous coal	9,166,572	12,514,372
Coke	1,384,254	1,416,632
Ores	3,636,607	3,802,162
Stone, sand, etc.	4,084,968	4,417,290
Other products of mines	381,112	483,922
	1910. Tons.	1911. Tons.
Products of forests—		
Lumber	7,302,037	7,364,964
Other products of forests	5,766,903	5,873,383
Manufactures—		
Petroleum and other oils	500,167	591,651
Sugar	617,231	614,529
Naval stores	37,007	18,422
Iron, pig and bloom	889,881	887,801
Iron and steel rails	717,081	616,980
Castings and machinery	1,189,214	1,137,218
Bar and sheet metal	568,901	939,916
Cement, brick and lime	2,254,934	2,495,178
Agricultural implements	434,928	540,061
Wagons, carriages, tools, &c.	173,137	205,106
Wines, liquors and beers	245,626	274,162
Household goods and furniture	388,631	412,529
Other manufactures	1,997,541	4,840,434
Merchandise	2,518,190	2,438,089
Miscellaneous	7,073,078	4,981,385

PROPOSED DRY DOCK AT SAULT STE. MARIE.

A shipbuilding plant and dry dock is to be built at Sault Ste. Marie. The company is working under an Ontario charter, with share capital of $1,200,000 and a proposed bond issue of about $1,000,000. The dock will rate under class C, or third class and will be entitled under the Dry Docks Act to a subsidy from the Dominion Government of 3 per cent. on cost for 20 years. The town of Sault Ste .Marie has also bonused the company to the extent of $5,000 per annum for 20 years, with a binding arrangement as to taxes.

The capital is being supplied by a group of French and Belgian capitalists represented by Mr. Charles Casoretty, LL.D., C.E., of Paris, France. The contract for construction is to be let at once. The operations at first will be confined to the dry dock, to the marine railway and to shipbuilding. Several orders for vesels have already been promised. Later, it is likely that other lines will be added, such as cars, engines, locomotives and the Williams and Janney power transmission device. This is an initial investment in Canada on the part of these capitalists and it may be followed by other investments of an industrial nature.

THE TRIPLEX BLOCK

A Triplex Block hung from a temporary rigging and used for laying pipe.

What is the Life of a Triplex Block?

WE don't know. Triplex Blocks built by the Yale and Towne Co. at the very beginning—twenty-five years ago—are still in actual use. The Triplex Block of to-day possesses greater lasting powers. With its steel parts—its chain superior to any other—its non-wearing gear movement—and the guarantee of a rigorous test before shipment under a fifty per cent. overload. It will outlast the man who buys it, no matter how young he may be.

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MONTREAL ST. JOHN OTTAWA TORONTO WINNIPEG
CALGARY SASKATOON VANCOUVER VICTORIA

NON-METALLIC PRODUCTS OF CANADA.

A production of 30 tons of actinolite valued at $330 was reported in 1910; no returns of production being received for 1909.

Returns from three smelters in which arsenic is recovered give a production in 1910 of 1,502 tons valued at $75,328, as compared with 1,129 tons valued at $64,100 in 1909. There were also 547 tons of arsenical ore shipped in 1910, valued at $5,716, as compared with 224 tons valued at $3,346 in 1909. The exports of arsenic in 1910 were 2,256 tons valued at $173,932, and in 1909, 1,556 tons valued at $119,673. The imports of arsenious oxide, in 1910, were 260,415 pounds valued at $6,891, and of sulphate of arsenic 257,451 pounds valued at $8,946.

The shipments of asbestos in 1910 were 77,508 tons valued at $2,555,974, and of asbestic 24,707 tons valued at $17,629. The shipments in 1909 were 63,349 tons of asbestos valued at $2,284,587, and 23,951 tons of asbestic valued at $17,188. The shipments in 1910 consisted of 3,740 tons of crude asbestos valued at $664,508, and 73,768 tons of mill stock valued at $1,891,466. Considerable quantities of both crude and of mill stock were held in manufacturers hands at the close of the year. Exports in 1910 were 71,485 tons valued at $2,108,632, as against 56,971 tons valued at $1,729,857 in 1909. Imports and manufactures of asbestos in 1910 were valued at $230,489, and in 1909, $196,742.

Shipments of chromite in 1910 were reported as 299 tons valued at $3,734, as compared with shipments of 2,470 tons valued at $26,604 in 1909.

The total sales of grain corundum in 1910 were 1,870 tons valued at $198,680, as compared with sales in 1909 of 1,491 tons valued at $162,492.

Shipment increased from 12,783 tons valued at $40,383 in 1909, to 15,809 tons valued at $47,667 in 1910. The exports are recorded as 10,834 tons valued at $35,234 in 1909, and 15,601 tons valued at $47,962 in 1910.

A small production of fluorspar was reported in 1910, of which two tons valued at $15 were shipped from the mine. About 7,461 tons of fluorspar were used during the year in steel plants.

Shipments of crude and milled graphite during 1910 totalled 1,392 tons valued at $74,087, as against 864 tons valued at $47,800 shipped in 1909. The production of artificial graphite in 1910 was reported as 1,221 tons, as compared with 257 tons in 1909.

Exports of plumbago in 1910 are reported as 788 tons valued at $53,008, and manufactures of plumbago valued at $66,658. Exports in 1909 were: Plumbago, 1,004 tons valued at $52,440, and manufactures of plumbago valued at $864. Imports of graphite in 1910 were valued at $112,853 and included. plumbago not ground, $4,867; blacklead, $10,048; plumbago ground and manufactures of, $45,042; and crucibles of clay or plumbago, $52,896. In 1909 the imports were valued at $94,392, including: plumbago not ground, $5,075. blacklead, $11,638. plumbago ground and manufactures of, $37,538; and crucibles of clay or plumbago, $40,141.

The production of grindstones, scythestones, and wood pulp-stones in 1910 was 3,973 tons valued at $47,196, as compared with 4,275 tons valued at $54,664 in 1909. The exports in 1910 included: stone for the manufacture of grindstones, 308 tons valued at $338; and manufactured grindstones valued at $23,164; the exports in 1909 were: stone for the manufacture of grindstones, 125 tons valued at $1,685, and manufactured grindstones valued at $13,942. The imports of abrasives in 1910 included: grindstones valued at $71,394; burrstones, $854; emery in bulk crushed or ground, $40,400; manufactures of emery, carborundum, etc., $92,890; pumice stone, $14,829. The 1909 imports comprised: grindstones valued at $69,554; burrstones, $2,001; emery in bulk crushed or ground, $29,752; manufactures of, $66,777, and pumice stone, $11,291.

The total shipments of gypsum crude and calcined in 1910 were 525,246 tons valued at $934.446, as compared with shipments of 473,129 tons valued at $809,632 in 1909. The tonnage of gypsum mined or quarried in 1910 was 548,019 tons, and the quantity calcined, 69,889 tons. In 1909, 493,086 tons of gypsum were mined and 63,670 tons calcined. The shipments in 1910 included: crude gypsum, 469,573 tons valued at $508,686; ground gypsum. 6,121 tons valued at $17,390, and calcined gypsum 49,552 tons valued at $408,370. In 1909 shipments comprised: crude gypsum, 423,474 tons valued at $457,038; ground gypsum, 8,814 tons valued at $26,159, and calcined gypsum, 40,841 tons valued at $326,435.

The exports of gypsum in 1910 were: 346,081 tons of crude gypsum valued at $416,725, and gypsum ground or calcined valued at $12,306. The 1909 exports were: 315,201 tons of crude gypsum valued at $372,286, and gypsum ground or calcined valued at $2,787.

The imports of gypsum in 1910 were valued at $169,798, including: crude gypsum, 12,271 tons valued at $21,073; ground gypsum, 6,690 tons valued at $13,242, and plaster of Paris, 19,045 tons valued at $135,483. The total value of imports in 1909 was $141,715, made up of: crude gypsum 3,958 tons, valued at $12,507; ground gypsum, 10,737 tons valued at $16,779, and plaster of Paris, 19,116 tons valued at $112,429.

Shipments of magnesite in 1910 were 323 tons valued at $2,160, and in 1909, 330 tons valued at $2,508.

The value of the mica production in 1910 as reported by mine operators was $190,385, as compared with $147,782 in 1909. The exports of mica in 1910 were 937,263 pounds valued at $330,903, as against 717,066 pounds valued at $256,834 in 1909.

Shipments of barytes in 1909 were 179 tons valued at $1,120, and no production was reported in 1910. The purduction of iron ochres in 1910 was 4,813 tons valued at $33,185, as compared with 3,940 tons valued at $28,093 in 1909.

The export of iron oxides in 1910 were 1,746 tons valued at $29,839, as against 658 tons valued at $7,956 in 1909. The imports in 1910 were: ochres and ochrey earth and raw siennas, 1,246 tons valued at $31,926; and oxides, dry fillers, fireproof umbers, and burnt siennas, 868 tons, valued at $23,467. The total imports in 1909 were valued at $39,497.

FERTILIZATION BY SEWAGE.

An investigation by Muntz and Massie in Paris, has shown that a permanent meadow yielding 4½ tons of hay per acre requires 120,000 cubic feet of sewage for phosphoric acid and 150,000 for potash; and that by irrigating with 150,000 to 175,000 cubic feet, given in eight or ten instalments during the growing season, the crops have sufficient for both water and nutritive material. Some land receives ten times this quantity.

COMPRESSION TEST FOR STONE BALLAST.

The committee on ballast of the American Railway Engineering Association has presented in its report for 1912 a compression test which the Office of Public Roads on the Department of Agriculture has agreed to make. The compression test is described in the report of the committee as follows:

A cylinder 2 in. in diameter and more than 2 in. long is drilled from the specimen of stone to be tested, by means of a diamond core drill, and sawed to a length of 2 in. by a band saw fed with emery. The specimen is finally faced off on each end by means of a power-driven grinding lap, on which water and emery are continuously fed.

The cylinder then has both ends embedded in plaster of paris, the bed being made as thin as possible and both ends being made parallel. The cylinder is next mounted on an Olsen test machine on a special bearing block between blotting papers, three thicknesses being placed at each end, between the cylinder and the steel-bearing faces of the machine. The load is then applied at a speed of 0.152 in. per minute, the machine being kept balanced during the application of the load.

The committee believes that with the former physical tests of stone for ballast and the compression test added, sufficient information will be given by which to compare the character of stone from various quarries from which it is proposed to obtain ballast.

The advantage of using approved physical tests of stone for ballast is pointed out to be the determination of the character of the stone and its fitness for ballast without the expense of opening quarries and of using the stone before it is known whether it will be suitable for ballast or not.

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Meets *every requirement*—Boiler Room or Machine Shop. Made of special compound that *resists heat* hence the *only* packing thoroughly adapted for high pressure uses. Makes tight joint under air or hot or cold water pressure. *Unaffected* by oil, liquor, ammonia, or alkali. Retains elasticity.

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Fine quality cotton duck with round core. Used like Hydraulic Packing, *only for lower pressure.*

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Best Packing for pump cylinders, inside-packed plungers pumping hot or cold water, and hydraulic elevators. Unexcelled for boiling water and high pressure hydraulic work.

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For cold and warm water pipes. Unexcelled in pliability, smoothness of finish and strength of cloth insertion. Made of heavier fabric than any other similar packing on the market.

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CONDENSED ADVS.

Advertisements on this page will be accepted hereafter at the following rates:—"Positions Wanted" advs., one cent per word each insertion; "Positions Vacant," "Agents or Agencies Wanted" advs., two cents per word each insertion; all other advertisements, three cents per word each insertion. A minimum charge of fifty cents per insertion will be made in every case.

CITY OF LONDON, ONTARIO.—ENGINEERING DEPARTMENT.—Applications are invited by the City Council for the position of Assistant City Engineer of London. Such applications must be enclosed in plain envelopes, and marked Assistant City Engineer, and filed with the City Clerk not lated than five o'clock on Thursday, April 25th, 1912. A full statement of qualifications and references must accompany each application. Geo. W. Wright, City Engineer.

CIVIL ENGINEER, German graduate, 35 years of age, with 17 years' experience, desires position with Canadian firm of Engineers or Contractors. Trolley and Railroad construction; engineer in charge of preliminary and location surveys; reinforced concrete works; paving works; irrigation. Expert estimator and designer. Box 26, The Canadian Engineer.

MECHANICAL ENGINEER—Desires position of responsibility. Holds British Board of Trade, first-class certificate, 12 years' experience running large triple expansion engines and boilers, refrigeratoring, machinery, and drawing office experience, commercial experience in Consulting Engineer's office. Apply John Bear, 335 Langside St., Winnipeg, Man.

YOUNG ENGINEER who hopes to graduate in May would like to secure an opening on the staff of some Civil Engineer or Surveyor. Box 44, The Canadian Engineer.

ASSISTANT Works Manager, at present with reputable firm of engineers in England, would like responsible position with Canadian firm. First-class testimonials. Draughtsman, Estimator, Superintendent, Organizer, and controller of men. Scotch nationality and training. Age 35. Box 238, Canadian Engineer.

WANTED.— Engineering draughtsman, accustomed to Railway work. Apply stating age, education, salary expected, etc., to Box 38, The Canadian Engineer.

FOR SALE.—New 500 B.H.P. Mirrlees-Diesel crude oil engine 200 R.P.M., delivery six weeks. Guaranteed fuel consumption full load 0.45 lbs. B.H.P. hour. Apply, Heaps Engineering Company, Limited, 445 Hastings Street, Vancouver, B.C.

PARSONS TRENCH EXCAVATOR FOR SALE.—Will excavate trench 28 to 78 inches in width up to 20 feet deep. Also has special frame and equipment for trench 22 inches in width up to 14 feet deep. In good condition and well supplied with extra parts. J. H. McKnight Construction Company, Limited, Toronto, Ont.

PLANT FOR SALE.—Little Giant Special Steam Shovel, 1¼-Yard Dipper. Also Large Size Steam Pile Hammer. The Randolph Macdonald Company, Limited, Toronto, Ont.

SAND, GRAVEL AND STONE SUPPLY.—Screen gravel a specialty. John Johnson, Colwell P.O., Ontario. Phone 79 B., Barrie.

MECHANICAL ENGINEER wants position. Several years works manager with modern engineering firm. Experienced draughtsman, mechanic, cost estimator and salesman. Steam, gas and oil engines, boilers, hydraulic pumps and mining machinery. Highest references. Box 24, The Canadian Engineer.

AN ENGLISH ENGINEER with ten years' experience in sewerage and sewage disposal works and water supply, is anxious to secure a position where such knowledge would be useful. Box 46, The Canadian Engineer, Toronto.

WANTED.—Architectural draftsman, capable of taking entire charge of designing large residences, schools, etc. Apply Box 48, The Canadian Engineer, Toronto.

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Contractors' Plant
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1 70-ton Steam Shovel, Atlantic (used three weeks)
3 Four-Wheel Dinkey Locomotives (narrow gauge)
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A NEW USE FOR THE ELECTRIC ARC.

The use of the electric arc as a heater of furnaces has been brought prominently before the public of late but the use of the arc as a means of displacing rivets in metal work would appear to be a novel departure in the use of this important agency. The British Insulated and Helsby Cables, Limited, of Prescott, Lancashire, England, have recently perfected a spot welder to replace riveting in sheet-iron ware.

In appearance the machine resembles a common machinist drill but the back portions of the machine enclose suitable resistance and transforming apparatus while the drill attachments are replaced with two electrodes for heating the material to be welded to the proper temperature. The electrodes, suitably shaped, are brought to bear on the spot where the weld is desired and a heavy current at low pressure is passed between the plates which rapidly brings the metal to the desired temperature. The current is interrupted when this condition is reached and the white hot metal is compressed by suitable means thus forming a strong clean weld. The electric power must be applied to the welder in the form of a single phase alternating current. The electrodes are constructed of copper and a stream of water is directed around them in order to reduce the wear. The resulting welds are very strong and tough and give the appearance of a slight abrasion on the metal.

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LOCK JOINT PIPE COVERS NORTH AMERICA

Sewage flowing through Lock Joint Pipe reaches the Atlantic Ocean, Pacific Ocean, Gulf of Mexico, Hudson's Bay and the Great Lakes.

Lock Joint Pipe is in use for sewers and water conduits in the following States: Massachusetts, Connecticut, New York, New Jersey, Delaware, Pennsylvania, Maryland, Virginia, Kentucky, Georgia, Florida, Ohio, Illinois, Kansas, Washington and Oregon.

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And in the Island of Cuba.

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MANITOBA, SASKATCHEWAN and ALBERTA—Canadian Lock Joint Pipe Co., Regina, Sask.
BRITISH COLUMBIA—Pacific Lock Joint Pipe Co., 1005 A St., Tacoma, Wash.; Globe Bldg., Seattle, Wash.

NORTHERN ONTARIO.

The two sections of Canada next to receive the impetus of capital, immigration and enterprise are Northern Ontario and the Peace River district. Both are rich in natural resources and possibilities but as yet are practically undeveloped. The natural resources and trade prospects of Ontario's Northland are exhaustively treated in a report just issued by the Toronto Board of Trade. It deals at length with the wealth of natural resources consisting of 20,000,000 acres of splendid agricultural lands, large mineral deposits, an enormous aggregate in water powers, and a considerable area of valuable timber lands. The assets, says the report, are the foundation of great industrial and trade expansion. Today, even, with but the fringe of the vast area settled, the annual purchasing power of the territory between North Bay and Cochrane is $45,000,000.

The report shows that Quebec province is getting considerable business in Northern Ontario. Many thousands of miners' and prospectors' boots are sold in the North by a Detroit firm, although Ontario houses are doing a good business. The competition of the French province is well assisted by railroad facilities, which will be improved. The distance of four cities from the town of Cochrane is shown in the following table:—

City.	Miles from Cochrane.
Toronto	480
Quebec	568
Montreal, via North Bay	613
Winnipeg	775

The present difference in distance between Cochrane and Toronto and Montreal is 133 miles in favor of Toronto. With the completion of the Grand Trunk Pacific, the distance of Cochrane to a Quebec centre will be reduced to only 88 miles in favor of Toronto. These are points which the Ontario business man cannot afford to overlook and which the Quebec houses have well in view.

How far this competition has extended in two recent years is seen in classified statements, supplied by the Temiskaming and Northern Ontario Railway Commissioners, showing the freight traffic into Northern Ontario from Quebec and Ontario points respectively. In 1909 the freight shipped from Quebec points was 11,404 tons, compared with Ontario's 162,904 tons. In 1910 the tonnage from Quebec showed a decrease from the previous year of 1,312 tons, while the tonnage from Ontario showed a decline in the same period of no less than 45,905 tons. Whatever was the cause of the aggregate decrease in the freight shipments, Ontario bore practically the whole of the burden, Quebec managing to maintain its business almost at the same level as in the previous year.

Examining the figures of 1910, it is found that the largest shipments from Quebec province were: cement, 1,688 tons; fruits and vegetables, 271 tons; hardware, 976 tons; hay, 894; machinery, 693; manufactured goods, 1,584; merchandise, 1,550.

The mining development of the North is treated at length. The ideal mining region, continues the report, is that in which the maximum amount of industry is created by the mineral itself and retained in the district. Of the twelve smelting companies receiving or bidding for Cobalt ores at the end of last year, six were Canadian, four American, one British and one German, with a New York agency. Trade naturally is given impetus by the establishment of additional plants. The question of a special effort to retain for Northern Ontario the smelting of its ores deserves the serious consideration of mine managers, the Government and its railway commissioners, the smelting companies and capitalists generally.

In 1910, as in former years, the tonnage treated in Canada was less than that shipped to the United States for treatment. The Canadian smelters, however, treated ore of a higher grade, with the result that they accounted for a little more than 50 per cent. of the total tonnage. In 1910 the three Canadian companies which have their plants at Copper Cliff, St. Catharines and Deloro treated 16,700,000 ounces. Three new smelting companies, with works at Orillia, Toronto and Swansea, are now entering the market for the purchase of ore from the Cobalt camp.

Smelters operated in Ontario should be able to compete well with foreign companies. The freight charges on ore shipped from Cobalt to Hamburg, Germany, for instance, were $13.47 per ton shipped via Montreal during the summer and $15.20 per ton via Boston in winter. This compares with a rate from Cobalt to Copper Cliff, for example, of $5.20 per ton, assuming that the value of the ore is above $49 and under $100 per ton. The establishment of smelters near the mines would have had an initial advantage in freight rates.

The Temiskaming and Northern Ontario Railway runs through two distinct countries. From North Bay to North Cobalt is chiefly a rocky country where minerals pay dividends. Therefrom to the terminus of the Government railroad at Cochrane is excellent farming land, which, in its natural state, is heavily laden with good timber. Even in the mining districts the soil has been cultivated to a small extent. The sight of a thriving potato patch within a few feet of a well-known silver mine at Cobalt brings to mind the picturesque window box of flowers in the city slum—it looks out of place, but is welcome, useful, and illustrates possibilities. The potato patch at Cobalt is an index of what can be accomplished on the land farther north, where, so far as we know, minerals do not tempt the farmer from his avocation, and where the soil has growing qualities equal to those to be found anywhere in the Dominion.

The valuable combination in Northern Ontario exists in few other lands. The water powers are largely found among the pine and hardwood forests and in many cases are contiguous to mineral deposits. Thus the raw materials and the power for their manufacture are side by side. There is scarcely any limit to the possible industrial development as a result of the Northland's water power resources. The waterfalls and the lumber may co-operate in the establishment of sawmills, sash and door factories, planing mills, pulp mills, match factories and other woodworking industries. The waterfalls and the minerals may co-operate in the establishment of stamp mills and other mining plants.

Electrically driven railways might act as feeders to the main and branch lines of the Temiskaming and Northern Ontario road. Development is accomplished on the lines of communication. The transportation of lumber, ore, raw and finished materials, and supplies would thus be facilitated, the water powers being the basis.

With the rapid progress made in the science of transmitting electric energy, many other industries can avail themselves of cheap power without necessarily building their factories in the immediate vicinity of the waterfall. Flour mills, sugar factories, chemical factories and many others could take advantage of the water resources.

QUEBEC'S MINERAL PRODUCTION

Product	Value in 1911	Value in 1910
Asbestos	$2,939,006	$2,667,829
Asbestic	19,802	17,612
Copper and Sulphur Ore	240,097	145,165
Gold	11,800	.....
Silver	11,500	.....
Bog Iron Ore	4,041	4,406
Ochres	28,174	33,185
Chromite	2,469	3,734
Mica	76,433	51,901
Phosphate	5,595	3,182
Graphite	33,588	15,896
Mineral Waters	62,607	68,155
Titaniferous Ores	5,684	5,292
Slate	8,248	18,492
Cement	1,931,183	1,954,646
Magnesite	6,416	2,160
Marble	143,457	151,103
Flagstone	500	890
Granite	308,545	291,240
Lime	284,334	279,306
Limestone	1,081,059	503,173
Bricks	1,135,501	906,375
Tiles, Drain and Sewer Pipe, Pottery, etc.	100,000	197,526
Quartz	1,125	2,013
Feldspar	600	.....
Peat	700	.....
Glass Sand	1,179	.....
Sand	114,500	.....
Totals	$8,567,143	$7,323,281

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An Engineering Weekly

THE GRAND TRUNK PACIFIC RAILWAY.

The Grand Trunk Pacific Railway Company, which was incorporated by Act of Parliament, 1903, is under agreements with the Canadian Government for the construction and operation of a line of railway across Canada, from the Atlantic to the Pacific Ocean, wholly within Canadian territory, of an estimated mileage of main line of 3,600 miles; in addition to which there will be constructed several branch lines of considerable length and importance, including a branch from the main line southerly 188 miles to Fort William and Port Arthur, on Lake Superior, for the purpose of reaching navigation on the Great Lakes; also from the main line southerly about 229 miles to North Bay or Gravenhurst, in the Province of Ontario, to make connection with the lines of the Grand Trunk Railway Company of Canada, and another from the main line southerly to Montreal.

This great undertaking has been projected to meet the pressing demand for transportation facilities in British North America, caused by the large tide of immigration which is now flowing into the country from Great Britain, Northern Europe, and still more extensively from the Western States of the United States of America.

The authorized capital stock of the company is $45,000,000, of which $20,000,000 may be issued as preferred. The Grand Trunk Railway Company of Canada is to acquire all of the common stock (except shares held by directors) in consideration of guarantees, etc., and must retain a majority holding during the term of the agreements with the government.

Constructing Line North of Lake Superior.

Mr. Charles Melville Hays was the originator of this project, and, according to Mr. Frederick A. Talbot, of London, England, who has made a considerable study of this railway and its history, Sir Wilfrid Laurier and his government must be credited with their great share of the work by securing the consent of the people of Canada to participate in such a project as a government transcontinental railway. The whole of the western country was canvassed religiously. No one knew for whom these parties were working, or just what the scheme in hand comprised, as it was revealed in a somewhat hazy manner. Secret meetings were held in the cities, large towns, villages, and even in remote settlements. Extreme caution had to be taken to prevent any tangible particulars of the undertaking reaching the management of the C.P.R., insomuch as the Canadian Pacific regarded the West as its own territory.

Investigation of the dormant wealth of the land through which it was to pass caused the promoters of the enterprise

On North Shore of Lake Superior.

to keep the line well to the north, so as to open a new country in the widest sense of the word. President Hays adopted a sound policy when he decided on following more the methods of the English railways, and that the first cost was to be the last. Any one connected with English railways knows how solidly this construction work is carried out, and that there are absolutely no permanent ways in the whole world better constructed.

The Grand Trunk Pacific called for the irreducible minimum in curvature and grades—the former were to be no sharper than four degrees and the latter not to exceed four tenths. The railway threads the mountains with a "ruling" grade of four-tenths, or 21.12 feet to the mile, against both east and westbound traffic. Rises not exceeding 52.8 feet to the mile have been sought diligently by railroad builders in North America.

The Dominion Government undertook to build one-half of the line from the Atlantic seaboard to Winnipeg, and to control it as a national undertaking, while the Grand Trunk Pacific was to construct the second half, stretching from Winnipeg to the Pacific Coast, and the government would assist in the construction of this latter section, inasmuch as it involved the crossing of the Rocky and Cascade Mountains, by guaranteeing the first mortgage bonds.

By deciding upon Winnipeg as the dividing point between the two parts the undertaking was split into sections of almost equal length, the eastern division measuring 1,801

miles from Moncton, while the western division is 1,755 miles in length.

The eastern terminus of the railway will be at Moncton, New Brunswick, from which point the seaport of Halifax will be reached over the Intercolonial Railway, a branch line being projected to St. John. The distance from Moncton to the first named port is 185 miles, and to the latter 89 miles. The western terminus will be at Prince Rupert, British Columbia, on the Pacific Coast, near the southern boundary of Alaska.

Commencing at Moncton, the line will take the most direct practicable route within the Province of Quebec, to the city of Quebec. At Chaudiere Junction, five miles above Quebec, the new line will cross the St. Lawrence River, thence taking a direct route, passing in the vicinity of Lake Abitibi, and to the north of Lake Nepigon, to Winnipeg, Manitoba.

Owing to the physical character of the country the Western Division is subdivided into the Prairie Section and the Mountain Section; the former extending from Winnipeg via Edmonton to Wolf Creek, Alberta, a distance of about 916 miles, and the latter, as its name indicates, being the section over the mountains from Wolf Creek, Alberta, to Prince Rupert, British Columbia, about 840 miles.

The country through which the Prairie Section of the railway will pass, contains land now known to be well adapted for the growing of wheat, which in extent is four times the wheat growing area of the United States, and is the great agricultural belt of the North-west. This land, which is now being rapidly taken up by settlers, produces rich crops the first year of cultivation and will furnish a large traffic for the railway as rapidly as it can be extended, therefore amply warranting the company in assuming the payments of the interest charge on the cost of construction, from the beginning. The Mountain Section, however, passing through the mineral deposits, will require a little longer time for development, and as stated, the government has therefore assumed the payment of the interest charges under its guarantee of three-quarters of the cost of construction, for the first seven years after completion (waiving their right of recourse on the company in the event of default, for an additional three years), and allowing for the period of construction, which is fixed at seven years, not until 1919 will the company be required to assume this liability beyond the interest charges on the one-quarter of the cost of construction under the guarantee of the Grand Trunk Railway Company of Canada.

Returning to the question of gradients, mentioned above, the Grand Trunk Pacific will benefit from these exceptional conditions by the great economy and low cost of operation which can be obtained from the commencement, when this item is of such importance in the case of a newly constructed railway at a time when the traffic and the revenue therefrom must of necessity be light, although with the gradual evolution of the enterprise and from explorations which are being made in all directions, it would appear that the period of light traffic will be of short duration.

The Mountain Section of this railroad lies between the 52nd and the 57th parallels of latitude. It is probable that no other area in North America can equal this portion of British Columbia in her natural resources. Where there is no agriculture and pasture, there is mining or lumbering to be developed, and where there are none of these, although they often occur in one district, there is at least trapping and hunting. Lying as it does, far to the north, the climate conditions have in the past been supposed to be extremely severe during the winter season, but the fallacy of this impression is rapidly becoming known on account of the reverse conditions actually existing, due in part large to the proximity of this territory to the Pacific Ocean and the influence of the Japan current. Before the House of Commons Agriculture Committee recently Mr. Elihu Stewart, Dominion Superintendent of Forestry, in testifying as to the resources and conditions concerning the northern country, having particular reference, however, to the district adjacent to Great Slave Lake, which lies many hundred miles still more northerly of where the Grand Trunk Pacific will be constructed, said that the growth of vegitation in the Mackenzie Basin was surprising, the sun in the summer being visible for about twenty hours out of twenty-four. On July 15th, at Fort Providence, near Great Slave Lake, on the Mackenzie River, about 550 miles north of Edmonton, Mr. Stewart said he saw wheat in the milk, potatoes in flower,

COMPARISON OF SUMMIT ELEVATIONS, MAXIMUM GRADIENTS AND TOTAL ELEVATION ASCENDED FOR VARIOUS TRANSCONTINENTAL RAILWAYS.

Name of Railway	Highest Summits	Max. Gradient in feet per mile		Total Ascent in feet overcome	
		East-bound	West-bound	East-bound	West-bound
Grand Trunk Pacific: Western Div. Winnipeg to Pr. Rupert..	1 Summit 3,712	21	26	6,990	6,890
Eastern Div. Winnipeg to Moncton....		21	31	....	....
Canadian Pacific....	2 Summits 5,299 4,308	116	116	23,106	23,051
Great Northern	3 Summits 5,202 4,146 3,375	116	116	15,987	15,305
Northern Pacific. .	3 Summits 5,569 5,532 2,849	116	116	17,830	17,137
Union Pacific System: Omaha to San Francisco. .	3 Summits 8,247 7,107 5,631	116	105	18,575	17,552
Omaha to Portland..	5 Summits 8,247 6,953 3,537 3,936 4,204	106	116	18,171	17,171
Western Pacific... ..	2 Summits 5,712 5,108	52.8	52.8	9,385	5,076
Santa Fe System...	6 Summits 7,510 7,453 6,987 7,132 2,575 3,819	175	185	34,003	34,506

peas fit to use, tomatoes, turnips, rhubarb, beets, cabbage, onions and other garden vegetables. The strawberries had been ripe there for some time, and the people had currents and gooseberries. To illustrate the heat, he said at Fort Chipewayan it had been 100 degrees in the shade for several days and nights. Indians coming from the Alaska boundary to meet the steamer Wrigley had lost two dogs from the heat in the Arctic Circle. He thought systematic exploration would show a surprising amount of good country, extending down from Slave Lake to Peace River. Along the Mackenzie River, spruce grew clear to the shores of the Arctic Ocean. There were aspen, white poplar, balm of gilead and birch growing as far north as Fort Macpherson. Mr. Stewart said that on Slave River he had passed a bank of burning coal about twenty miles in length near Fort

Norman, which Mackenzie had reported burning in 1789.

The track is laid continuously from Fort William on Lake Superior via Winnipeg and Edmonton to Prairie Creek, Alberta, 1,412 miles, and a daily passenger train service between Winnipeg and Edmonton, 792 miles, was inaugurated July 3rd, 1910. Train service has also been established between Fort William and Winnipeg and between Edmonton and the end of the track at Prairie Creek.

Thriving towns are springing up where a few months ago there was nothing but the bare prairie; grain elevators, warehouses, dwellings, stores and other evidences of remarkable activity are presented immediately following the laying of the track. The growth is especially astonishing at the division points or terminals of Rivers, Man., Melville, Watrous and Biggar, Sask., and Wainwright and Edson, Alta., and there are many other towns which give promise of notable development.

OPTICAL DETERMINATION OF STRESS.

In his second lecture at the Royal Institution, London, Eng., on "Optical Determination of Stress and Some Applications to Engineering Problems," Professor E. G. Coker first discussed the determination of the lines of principal stress by optical means, taking as an illustration a particular case in which the central lines of a series of dark bands of inclination were shown on a tension member having two fine saw-cuts in it, which diminished its effective cross section by one-half. Great use might be made of the lines of equal inclination, as the positions of the dark bands appeared to be independent of the physical properties of the material. Professor Filon had, in this way, verified experimentally some of the results of his mathematical researches in elasticity, by observations of bands of this type. For many purposes, however, a method which made use of both isoclinic and isochromatic lines was convenient, but it was important to be able to distinguish between black bands which denoted no stress at all and those which showed the positions for which the planes of principal stress coincided with the principal planes of the polarizing and analyzing apparatus. In a general way it was possible to distinguish between each kind, if the stressed plate of material were turned round in its own plane, and was viewed in a beam of plane polarized light between crossed Nicols. Some bands moved while others remained stationary, and the former could be identified as isoclinic lines and the latter as belonging to the isochromatic group. It was often convenient to show this latter system in their true relation to one another, without disturbance by the dark bands due to the optical system. This might be accomplished by using circularly polarized light. Any stressed specimen, viewed under such conditions, showed at every point a color proportional to the difference of the principal stresses, and, since the shear was proportional to this difference, a picture of the shear stress throughout the plate was obtained.

Sudden Changes of Section.—Proceeding to consider a few cases which arose in practical applications of engineering work due to sudden changes of section, the lecturer said one of the simplest examples was afforded by a rivet hole. The effect of a simple pull was to cause a complicated stress distribution in the neighborhood of the hole, due to the crowding together of the lines of stress. It was easy to show experimentally that, if the hole was small compared with the breadth of the plate, the maximum stress rose to about three times its normal value, and theoretical calculation verified the experimental values. In a line of rivet holes the maximum stress at the minimum section could be readily determined. In a riveted joint the distribution was still more complicated, because the stress was carried from plate to plate by the direct pressure of the shanks of the rivets, and some idea of the intricate nature of these practical problems might be gained by comparing similar members under the same loads, in which the rivet holes were first without rivets; secondly, had rivets inserted; and, finally, had rivets in them by means of which the load was applied to the member.

Another type of discontinuity was afforded by semi-circular holes and rectangular slots in plates and beams. For example, in a tension member with two semi-circular notches in it, away from the discontinuity the lines of principal stress formed a rectangular system, but as they approached the notch they came closer and closer together, and at the waist the nearness together of the lines at the periphery indicated that the greatest stress was reached there. If the notches were small compared with the breadth, the stress rose to twice its normal value. If the notch was rectangular the stress at the re-entrant corners became very great. A similar notch in the form of a square hole in a plate forced the lines of stress to pass through the narrow spaces on each side of the hole, and here, again, the corners of the square showed by the close spacing of these lines, and the color effects on the specimen, how great was the influence of this kind of discontinuity.

Another subject of interest and of great importance in practical work related to the behavior of members like springs, hooks, links of chains, and the like, in which the curvature of the member was an important factor in the distribution of stress due to an applied load. A case which had some resemblance to that of a circular hook section was found in some forms of boiler, in which the flues containing the fire grate and for the circulation of the hot gases of combustion were corrugated in order to increase their strength. The determination of the stress distributions in members like these and in the parts of machines and the like, which it was the special province of the mechanical engineer to construct, was one of the greatest complexity, and long experience of the behavior of materials obtained by first-hand acquaintance in some particular branch of this profession as in, for example, the design and construction of tools or locomotives, could not be replaced by any experiments on models. They could help, however, and indeed mechanical engineers did not require to be convinced on this matter, as the use of models of machines for all kinds of practical purposes was the rule and not the exception.

THE MOTOR SHIP "SALENDIA."

The East Atlantic Company have recently purchased a new vessel designed for ocean traffic and propelled by oil engines.

The "Salendia" is 350 feet long with a beam of 53 feet, and a gross tonnage of 4,964 tons, and is fitted with two sets of four cycle Dissel motors, each with eight cylinders 20.8 in. by 28.7 in., giving together 2,500 i.h.p. at 140 r.p.m. built like the vessel herself, by Messrs. Barmeister & Wain, of Copenhagen. With a dead-weight cargo of 7,400 tons the displacement of the vessel is 9,800 tons, with a speed of 11 knots, on a consumption of 500 lbs. of oil an hour. The storage capacity of the double batten being for 900 tons or sufficient for a round voyage of 20,000 miles at full power. The vessel left her berth in the West India docks recently and the manœuvring necessary in order to bring her into the lock afforded a great demonstration of the ease with which the engines were started and reversed.

ELECTROLYTIC SEWAGE TREATMENT.

Oklahoma city drains mostly into the North Canadian River, but partly over the divide to the north into Deep Fork. Two years ago the city built a septic tank, costing $8,000 to accommodate some of the people on the Deep Fork slope. Later on bids were received for contact beds to purify the septic effluent. The lowest bid for the cantact beds was $17,000, and at this stage of the proceedings Mr. A. J. McMahan (representing the Electro-Sanitation Co., of Los Angeles) offered to install an electrolytic sewage treating plant for $12,000 and guarantee the results. The unsatisfactory results from the septic tank wrought a change of policy on the part of the city council and instead of building the contact beds, the council, on advice of W. C. Burke, then city engineer, entered into a contract November 4, 1910, for the installation of an electrolytic plant to treat the Deep Fork sewage.

Before the plant had been in operation two months, the use of the septic tank was abandoned except that the small grit chambers are utilized for eliminating the coarser matters. A by-pass now takes the sewage around the main chambers of the septic tank to the reservoir of the electrolytic plant. The results are much more satisfactory without the help of the septic tank. The plant is described in a recent issue of "Engineering and Contracting" by Mr. Howard V. Hincley, consulting and supervising engineer, Oklahoma City.

Description of the Plant.—There is a 36,000 gal. reinforced concrete reservoir designed to hold the night run of sewage for the present and eventually to act in the capacity of an equalizer to relieve the plant of any sudden fluctuations in the rate of flow at different hours of the day. Three 8-inch supply pipes conduct the sewage from reservoir to treating flumes. A wasteway carries the treated sewage into the gulch. The supply pipes are separately operated by three valves. The electrical machinery is on a platform about 15 ft. x 18 ft., 2½ ft. above the floor and about even with the tops of the flumes. On this platform are also a table and a filing case. The drive consists of a 7½ h.p. alternating current motor using commercial current at 220 volts. This motor is direct connected, under the switchboard, to a 3 kw. multipolar direct current generator and exciter, all resting on a single bedplate 2 ft. x 5 ft. The combination is designed and built for this special service and delivers to the copper cable conductors of 1,000,000 circular mills 800 to 900 amperes at a voltage of 1½ to 3, these being the limit between which the desired results are obtainable, varying somewhat with the character of the sewage. A double pole, double throw, knife switch allows the reversal of the current at pleasure and a knife switch at the upper end of each flume cuts on or off the current for that flume. Owing to the high amperage as compared with the low voltage the switches and conductors are necessarily heavy. If only one flume is in use the ammeter is set at 270 to 300. The building is of concrete blocks 18 ft. x 50 ft. on the inside with flat roof and beams exposed on the inside, 8ft. high over platform and 10½ ft. high over main concrete floor which has a slope of 1 in. and on which the flumes are supported on wooden blocks 6 in. x 6 in. x 26 in. The building has one 3 ft. x 7 ft. door, one 6 ft. x 7 ft. double door, and 12 pivoted windows about 3 ft. x 3 ft. just above the ground line.

Electrodes.—In each flume there are ten electrode sets spaced about 6 ins. apart, each set consisting of 27 cast iron plates each 3/16x10x24 ins. Alternate plates of each set form the anode and cathode respectively, and are both separated and electrically connected by cylindrical bushing conductors. These are fitted upon bolts on which they are drawn together for contact by nuts back of the hangers. As these bolts hold up only the ends of the plates, two other bolts of ⅜-in. iron covered with 1/16-in. rubber tubing are passed through the plates in the same plane with the conductor bolts, and on these bolts the plates are separated by cylindrical insulating bushings of hard rubber. Each of the 810 cast iron plates is capped for its entire length with a copper channel of No. 23 (16 oz.) copper 1½ in. x 24 ins., weighing ¼ lb. These copper caps add to the chemistry of the treatment and materially lengthen the life of the electrodes by protecting the plates along the upper edges where the corrosion would otherwise be abnormal. The plates must be decomposed to perfect the treatment, but it is desirable to have the decomposition as evenly distributed as possible and the gases arising tend to throw the reactions to the tops of the plates. Each set of plates with bolts, insulators and hangers forms a complete detachable, interchangeable unit.

Flumes.—The three flumes are 18 ins. deep, 22 ins. wide and 30 ft. long, made of 2-in. plank, dressed and painted three coats, held in shape by light bolts every 16 ins. in sides and bottom and by light iron straps across the top every 6 ft. The flumes are spaced 3 ft. apart; where the planks butt against each other wooden splines are used and there is no trouble in making a tight flume. Each flume has two insulated copper bus bars ⅜ in. x 1¼ ins., which bring the current from the knife switch at head of flume and from these bus bars the plates are charged through copper straps connecting the bus bars with the hangers. These straps have each 1/10 the conductivity of the bus bars. Baffles 3 ins. high, prevent any truant microbes from scampering among the floor under the plates. They are of sheet metal hinged at the upper edge over a light rod so that when not in use they may be lifted by a wire handle out of the way for washing out. Fixed baffles of sheet metal on the sides of the flumes projecting 1½ in. and located at the upper ends of the electrode sets, prevent the truants from sneaking along the sides of the flume. Two inches of clear space is allowed under the plates for flushing. At each end of the flume there is about 18 ins. of clear space and between the electrodes about 6 ins. At the lower end of each flume is a cross plank on which is fitted an adjustable weir gate which both regulates the depth of the water over the electrode plates and measures the flow. The weir is adjusted by means of nuts on two vertical bolts but it is found in practice that the spring of the plate and bolts is ample to hold the weir in position and the nuts are seldom used. There is also a washoutgate, that lifts up out of the way for flushing. The water is generally kept 2 ins. deep over the plates, as this seems to give as good results as either greater or less depths.

Operation.—The current from the commercial wires is turned on to the motor which drives the generator. The ammeter is set at 270 to 300, according to the operator's judgment. The valve is opened to supply raw sewage from the reservoir to one flume, or the ammeter may be set at 810 to 900 and the valves open to all three flumes with volt meter reading from 1½ to 3. The baffles are lowered and presently the plates are submerged and the sewage becomes milky. It is in a state of thorough and minute ebullition and before it commences to flow over the weir at the foot of flume it is covered with a white foam of gas bubbles. The impurities in the sewage passing between the plates which are spaced ½ in. apart, and which are alternately

anodes and cathodes, have become the electrolyte, short-circuiting the current, and millions of globules of water have been decomposed into the original elements, hydrogen and oxygen, which, being liberated in the nascent or formative state, produce remarkable results. The offensive odor, which is strong in the reservoir, has disappeared upon entering the flume. Sulphuretted hydrogen cannot exist in the presence offerric oxide in the electrolytic treatment. The treatment goes on down the flume and down into the gulch below the plant as the sewage and froth of gases roll over each other. There is no scum on the treated sewage except the white froth of generated gases and there seems to be a material lessening of the scum previously accumulated in the gulch.

The time taken by a particle of sewage to pass through the flume and through the ten electrode sets when treating 250,000 gals. per flume per 24 hours, is about 3 minutes. An increase of amperage gives an increase of diffusion or volume of current and consequently of ebullition, while an increase of voltage puts more iron and copper into the chemistry of the treatment. A very small portion of the sludge is collected upon the plates through the agency of the ferric hydrate. Several years ago, when the "Electro" was in the embryonic state, the plates were cleaned by steam through perforated pipes laid on the bottom of the flumes. This was both expensive and unsatisfactory. They are now cleaned by simply reversing the current, and the sterilized sludge, when thrown off from the plates, has the color of ferric oxide. By the reversal of the current the uneven corrosion of the plates is again eliminated. The low voltage necessary to decompose the water and organic matter is in contrast with that reported by Mr. J. L. Campbell in 1908 when he utilized the same process for removal of scale from hard boiler water at a pressure of 112 to 115 volts, the treatment costing $479 per million gals. The electrolytic method—ideal for sanitary or organic purification—seems so far to be wholly unsuited for the removal of scale.

Chemistry.—The process is electro-chemical. Oxygen, hydrogen and chlorine are liberated in the nascent state; are powerful reagents and render the effluent neutral—a result not obtained by either chemical or biological treatment. Owing to oxidization no traces are left of albuminates or nitrogenous bodies, which give so much trouble in the way of secondary putrefaction in septic treatment. Nitrates are changed to nitrites and the iron and copper compounds coagulate and clear the effluent. The oxy-chloride of lime and magnesia destroys dangerous (including typhoid) bacteria, while the free sulphuric acid generated in the process kills cholera germs if present.

Compared with Electrolytic Plant at Santo Monica, California.—The electrolytic plant at Santa Monica, Cal., has its outfall in the surf at the bathing pier. Even there—with nature lashing the oxygen of the air and the chlorine of the sea water into her purification process by wave action—a nuisance was noticeable when the plant was temporarily shut down. What then might be expected when a half-million gallons of sewage are dumped daily into a dry gulch, for six months of one of the driest seasons ever known in Oklahoma, and especially when the septic tank, and later the grit chamber, have been periodically cleaned out and emptied into the same dry gulch? The official report of the city bacteriologist says that "below the tanks (flumes) and long before the material has reached the creek the outflow was clear and quite limpid and distinctly free from odor."

Bacterial Reductions.—The following tests, made at three different times at two different places, tend to show a reasonable percentage of destruction of pathogens in the process, as well as a reasonable uniformity of results obtained.

Dr. Frederick Salathe, Santa Monica, Cal., reported November 16, 1908, bacteria removed 99.1 per cent. "And those remaining were completely destroyed."

Louis A. Turley, state bacteriologist, Norman, Okla., reported October 2, 1911:

	Per cent.
Flume No. 1 reduction—Total bacteria	86.0
Flume No. 1 reduction—Disease bacteria	98.5
Flume No. 2 reduction—Total bacteria.....	88.0
Flume No. 2 reduction—Disease bacteria	98.4
Wasteway 20 ft. below reduction—Total bacteria....	92.5
Wasteway 20 ft. below reduction—Disease bacteria..	99.0

Clarence E. Lee, city bacteriologist, Oklahoma City, reported September 30, 1911:

	Per cent.
Flume No. 1 reduction—Total bacteria	99.75
Flume No. 2 reduction—Total bacteria	99.82
Wasteway 20 ft. below plant—Red. total bacteria....	99.83

Dr. Lee says, "It is a noteworthy fact that after leaving the plant the number of germs relatively decreases and the ordinary algae, which do not seem to be affected in the least by electrolysis, relatively and rapidly increase. I find from examination that those germs which are not killed by this process are so markedly inhibited that they are easily cared for by the ordinary algae found in all surface water; consequently with increased admixture with ordinary algae and exposure to air and sunlight the objectionable features are rapidly removed in proportion to the distance from the plant. The findings 20 ft. below the plant correspond to several thousand feet below in small streams in untreated material."

Referring to the last quotation above the absence of odor in the gulch after six months of deposit of sewage therein (the septic tank and grit chamber having always been cleaned out into the gulch) seems quite remarkable. The gases carried into the gulch, tumbling over and over with the water, seem to have continued the purification work far below the plant.

On recommendation of Guy E. Blackwelder, Commissioner of Public Works, the Deep Fork plant was unanimously accepted by the municipal commissioners October 6, 1911, and plans have been ordered for a similar plant for the Packingtown district which is to treat not less than two million gallons daily and to cost not more than $42,000.

Sludge.—One of the greatest nuisances of sewage treatment in the disposal of the sludge. With a reasonable breaking up of the legitimate solids by a long run or by centrifugal action there is but little sludge that needs to be taken out, the finer particles all being thoroughly oxidized in the flumes. As to whether the coarser and foreign matter shall be held back by baffles or by screens or both is simply a matter of detail. Experience with this plant seems to indicate top and bottom baffles followed by a vertical screen over face of grit chamber outlet—the screen to be handy of access through the manhole cover for cleaning.

Cost of Operation.—The cost of current guaranteed not to exceed $750 per annum or $2.74 per million gallons should probably average about 810 amperes at two volts costing 4 cts. per kw. hour plus 25 per cent. motor loss equals $709.50 per annum. The item of plate renewals is not guaranteed but in the Santa Monica plant treating a half million gals. per day, this item has not exceeded $150

per annum. The attendant at the Oklahoma City plant is paid $55 per month and has the use of house and grounds. His duties keep him busy for two or three hours a day. He could easily handle two or three plants, a mile apart—or five miles apart, if fairly well connected by street car service.

The total estimated cost of operation, including proper fixed charges, is given in Table I.

Table I.—Estimated Cost of Operating Oklahoma City Electrolytic Sewage Purification Plant.

For—	per annum.	Per million gallons.	Per thousand gallons. Cents.
Electric current	$ 709.50	2.59	0.259
Attendant	660.00	2.41	0.241
Lights	40.00	0.15	0.015
Total operating	$1,409.50	$5.15	0.515
Renewal of plates	200.00	0.73	0.073
Depreciation of electric machinery	100.00	0.37	0.037
Five per cent. on investment	800.00	2.92	0.292
Total operating and fixed charges	$2,509.50	$9.17	0.917

The investment charge is computed upon $16,000, of which $1,000 is for attendant's residence and $15,000 is understood to be the price hereafter for a three-quarter million gallon plant. This plant, however, being introductory, was built "under the market" for $12.000. In a larger plant these figures would be reduced 20 to 30 per cent. It seems inadvisable to make any statement as to the general cost of electrolytic treatment of sewage per capita—even approximately—as long as water consumption per capita is reported all the way from 30 to 300 gals. per day and sewage flow from 15 to 300 gals. The cost must be computed upon the basis of the sewage flow in each case.

Conclusions.—The work done by this plant seems to justify the following conclusions: 1. That the septic tank in connection with the electrolytic sewage treatment is a hindrance—not a help. 2. That sedimentation in connection with the electrolytic treatment of sewage is neither necessary nor helpful. 3. That a centrifugal for atomizing the solids and a screen, or series of baffles, or both, for the elimination of the incorrigibles, seems advisable. 4. That a forebay or reservoir, which may be used to hold the night run during the earlier life of the plant, and to act as an equalizer when operated 24 hours a day, is advantageous. 5. That the necessary chemicals for the treatment of sewage are furnished by the electrolytic process. 6. That the nuisance and expense of handling sludge may be largely (but not wholly) eliminated. 7. That the effluent from the electrolytic treating plant is sterilized, deodorized, neutral, non-putrescible and harmless.

TELEPHONES USED IN THE RECENT REVOLUTION IN MEXICO.

A report from Mexico states that the latest revolution, planned by General Campa, is responsible for an improvement of the telephone as a war instrument. General Campa is an electrical engineer and has formed a corps of line-men which precede the main detachments and are instructed to have telephonic communications completed with the other commanders and the base of supplies by the time that General Campa arrives on the scene of activities

RECENT IMPROVEMENTS IN RAILROAD TRACK LAYING.

Railroad track laying is becoming a great factor in the industrial world as time advances, and the recent improvements placed on the market to aid in this work are of interest not only as a means of improving the methods now employed, but as original ideas connected with the engineering profession generally. Most of the apparatus about to be described is dependent on the electric current for operating power and as this factor is not always available, the company manufacturing these goods (The Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill.) have devised a portable gas-driven generator that will operate some of the smaller devices and will doubtless be improved and enlarged so as to operate machines for heavier work. In municipalities and upon the tracks of electric lines current is available for the maintenance of the larger machines and the operation of these, except in isolated cases, has so far been confined to this class of track.

Fig. 1 will present an accurate idea of the electric spike-driving apparatus that is capable of placing 5,000 screw spikes firmly in the track during one working day.

The car is built with a welded steel frame, the whole being carried on flat elliptic springs. It is equipped with

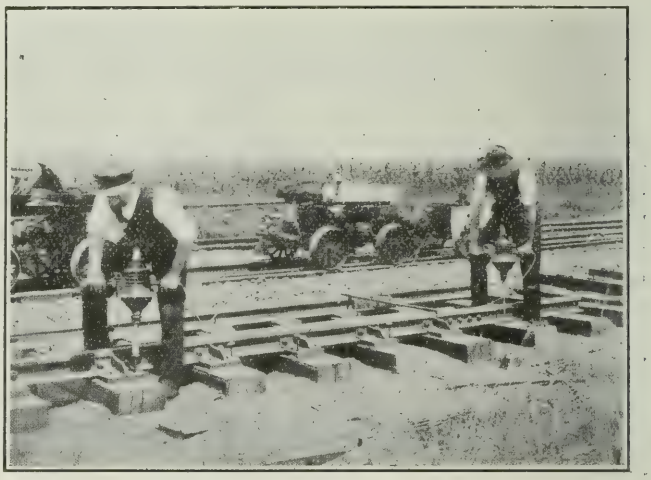


Fig. 1.

a 12-horse power gasoline engine, direct connected through a suitable clutch to a 6-kw. 125-volt direct current generator, suitable transmission for the car, also being provided, which gives a speed of fifteen miles per hour. This outfit is capable of operating two electric spike drivers; four electric wood boring machines, and an electric grinder, which is mounted on the car for the grinding of the tools. A reel containing five hundred feet of cable is mounted on the car and a light portable switch-board, containing the magnet switches and plug connectors, is provided, to which to connect the spike drivers and wood boring machines. Seventy-five feet of cable is attached to each of the portable tools, thus giving a range of action of five hundred and seventy-five feet on each side of the car, or a total of eleven hundred and fifty feet.

The car weighs fourteen hundred pounds, and can be easily set off of tracks in service out of the way of passing trains.

The spike driving end of the machine is illustrated in Fig. 2(A), and consists of a specially wound, portable electric motor, with suitable gearing, the electric circuit being controlled by means of a magnet switch, mounted on the portable switch-board, previously referred to. This switch itself is under the direct control of the operator by means

of a push button on the driver, and the tool may be started or stopped at the will of the operator. In regular operation, the tool is started by the operator and automatically stopped by the opening of the magnet switch when the spike is driven home. This magnet switch, which is shown in Fig. 2(B), is adjustable so that spikes may be driven just as tight as occasion may require.

This company manufacture a car for inspectors and others whose business necessitates them being in close touch with the track work. This car has the same general outside appearance as that used for the spike drivers, but is fitted for the conveyance of eight workmen and their tools and will maintain a speed of twenty miles an hour.

The engine of this car has no cooling device, yet it never overheats and will run under almost any climatic condition. It is remarkably simple in construction and has the fewest possible number of parts. It is economical in fuel consumption, runs smoothly and steadily, and is so easy to operate that only a little instruction is required to enable any one to run it.

The engine is equipped with a special carburetor designed and built for it. This carburetor has the same simplicity of construction and operation which distinguishes the engine itself. It has neither needle valve or float. It is easily adjusted and once regulated needs no further attention.

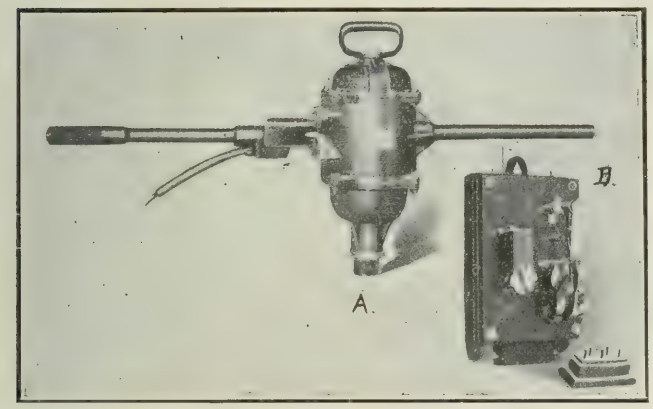


Fig. 2.

The cars are all equipped with magneto ignition system. A special high-tension magneto is utilized, and the use of timer, spark coil and dry cell battery is dispensed with. The magneto used upon the cars is very simple in design, but is efficient, reliable and durable. It has no electrical contacts, no moving wires and requires no switch or timer. It has no adjustments and no parts which can be adjusted. It produces a very hot spark, and the strength of this spark is quite independent of the speed at which the car is running. The only parts of the magneto which are subject to wear are two hardened steel blocks, which can be replaced at a very small cost. The wear upon these blocks is very slight, however, and on actual test a car was run five thousand miles without any part of the magneto showing any appreciable wear. The working parts of the magneto are enclosed and it is both dirt and water proof The only outer wires required are those running to the spark plugs. It operates equally well in either direction, and thus does away with a reversing switch when used with a reversible motor. In addition to furnishing a more reliable ignition, the use of this magneto eliminates the possibility of coil and timer troubles, also the necessity of replacing battery cells, which is always present on cars having dry cell battery ignition.

The car has a slatted seat top hinged to open full length and every portion of the mechanism is accessible to the operator easily and quickly. The tray frame has a box for carrying tools and a twelve-inch foot-board for the operator. The car has two-lever control and a brake that is easily reached by the operator from any position. Fig. 3 is from a photograph of this car.

Tools and other appliances operating under currents

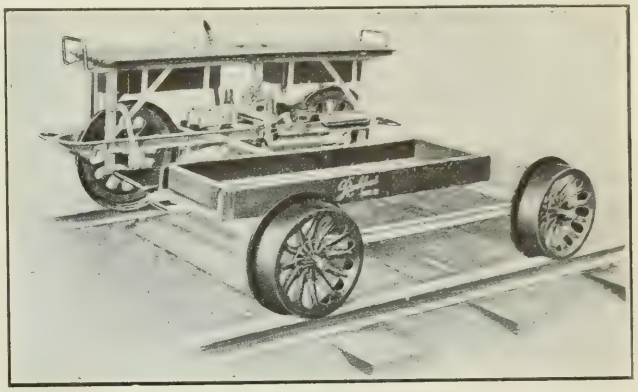


Fig. 3.

of low voltage would not require the care and forethought spent upon the track drill shown in figure 4 A and designed for use upon street and interurban railways. The high voltage and rough handling to which tools for this class of work are subjected calls for the careful design, insulation and general construction. An examination of the cut will show that the frame of this drill does not bolt to the track, but is simply hooked over the rail to be drilled, the operator holding down the other end by sitting on the seat provided, and thus brings him into convenient position to operate the feed. The side spindle of the drill permits of close drilling to the ties without the use of an angle attachment, and the vertical adjustment screw with guides for the drill affords a ready means for locating the holes vertically on ordinary tee or deep girder rails. The horizontal rods are of heavy seamless drawn tubing, and the bearing surface of the drill guides on the rods is very long, insuring true, straight holes, so essential for efficient bonding. The cross-

Fig. 4 A Fig. 4 B.

bar carrying the feed nut is located on the horizontal rods by means of eye pins which are easily withdrawn for the rapid removal of the drill from the track after drilling the hole or for sharpening the drill points. A series of holes in the horizontal rods provides means of accommodating varying lengths of bits. The drill proper may be removed from the frame by taking out four caps which allow the tool to be used as an ordinary electric portable drill. The magnets of this motor are wound for a pressure of six hundred volts.

Figure 4 B illustrates a heavy duty portable electric track grinder for use in grinding joints or for bonds. It carries a 6 x 1¼ x ⅝ emery wheel and revolves at a speed of 2,400 r.p.m., and has plenty of power for rapid work.

THE CONSTRUCTION OF WOOD BLOCK PAVEMENTS.*

By Day I. Okes.

As the success of a creosoted block street is dependent upon a continuous smooth surface, it is essential that the concrete foundation surface have as near the contour of the final pavement surface as possible. Where gravel concrete is used, it is advisable to have the foundation surface made by drawing a template over it. Where stone concrete is used, work should be done to a template curve.

The cushion upon which creosoted blocks are laid should never exceed 1 in., and it should be either ¾ or ½ in. where concrete is templated to an even surface; in fact, the use of the sand cushion under creosoted block streets is essential only in order to obtain a smooth wearing surface of creosoted block pavement.

Sand is not generally designated for the cushion material. Where there is vibration of pavement, as between car tracks, it is most advisable to use a mortar cushion. The manner of placing this cushion is to mix the sand and cement dry, and pull it with a template in a similar manner to pulling the sand cushion. The blocks are then placed and rolled to the final surface contour, the pavement surface is flushed with water in order to dampen the mortar cushion, and is left set up. After the pavement becomes dry the filler can be applied.

In the case of a creosoted-block pavement under heavy traffic, the motor cushion is preferable to the sand cushion, inasmuch as the set in this mortar cushion prevents washing of water leaking through the interstices and prevents displacement of the block surface due to flowing of the cushion and consequent rutting under heavy loads.

The objection to this mortar cushion is the time required to set before the pavement can be used. It has the advantage of making possible the use of the sand filler on lighter traffic streets, inasmuch as it provides against the washing away of the cushion during the iron-out of the pavement and the sealing of the joints. It is advisable to do away with a bituminous filler which becomes sticky in hot weather.

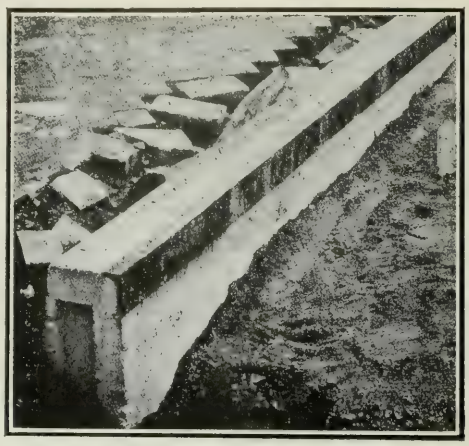
Provision may be made for expansion, first, by producing a block of the kind of wood and oil, and with the required impregnation to allow a minimum percentage of absorption under conditions where water or moisture surround the block entirely, or to provide by construction a sealing of the blocks on the bottom by a mortar cushion and on the four sides by means of a bituminous filler.

As to a satisfactory oil or treatment to be used for creosoted wood block paving from a constructor's standpoint, there has been trouble with heavy, or, as it is called, "waterproofing" oil in the bleeding of the blocks. It is sometimes contended that this bleeding is due to the manner of treatment and to the action of the blocks expanding in the street. However, when the use of a lighter oil under 1.10 sq. gr. is prevalent, trouble was not experienced with the oil exuding and staying on top of the pavement. So if a straight-run creosote oil is used and provision is made against absorption of moisture by the use of a dry mortar cushion and a bituminous filler which would not cut back by the oil from the blocks or would not soften and run in the hot weather —that is to say, an asphaltic-base bituminous filler—there would be a minimum amount of expansion and movement of the blocks. Such a pavement laid smooth would remain so under traffic and weather conditions.

* Abstract of paper presented at annual convention of Wood Preservers' Association, Chicago.

PREPARED CONCRETE CURBING.

A method of lessening the labor of paving and sewer work has recently been introduced by a company in Pittsburg, U.S.A., and is conducted on the same lines as that used in the manufacture of other concrete objects.

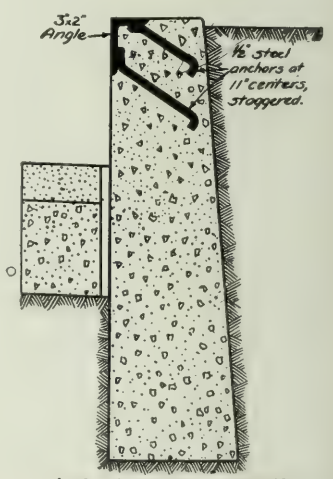


Concrete Curb Set to Grade.

The shop system of manufacturing concrete curb units for assembly in the field, eliminates all form work on the street and makes construction in any weather possible. Under good shop conditions, it should be possible to obtain a finished product of high quality at a cost comparable with that for the cast-in-place curb of equal quality. The curb as made, ready to ship, is 5 feet long and of three sections, one 6 by 24 inches for block paved streets under heavy traffic; another 6 by 21 inches for brick and asphalt paved streets under heavy traffic and a 5 by 24-inch section for block paved streets under light traffic. The exposed corner of each is protected by a steel angle held in place by anchors electrically welded to the back of the angles and embedded in the body of the concrete. These anchors are of ½-inch round rod and extend nearly to the opposite face, and are placed on 11½-inch centres. The sections are cast with mortise and tenon joints, so that they lock securely when placed.

The Neville Concrete Co., Neville Island, Pittsburg, who are the only manufacturers of this curb in the field at present, have sold to the city of Pittsburg over 20,000 feet, for use within the city, and are trying to have it adopted as standard by the city of Pittsburg.

The welded angle is not patented, but the company's location with regard to steel mills will probably make it possible for them to manufacture and sell the steel for use by other concrete products manufacturers at a price lower than would otherwise be obtained, even were they to use the same electrical welding machines.



Detail of Angle Protection and Anchors.

The cost of the 5 by 21 inch section, the smallest size, is 41 cents per lineal foot, f.o.b. Pittsburg, and for the 6 by 24-inch size, the largest, 48 cents per lineal foot. This makes it possible for them to compete satisfactorily with other types of curb over a radius of seventy-five to a hundred miles out of Pittsburg.

NOTES ON STRUCTURAL STEEL DESIGNS.*

By Albert Reichmann.

Structural steel nowadays is used so very extensively in the construction of our railroads, industrial buildings, office buildings, apartment buildings, and in almost every means of conveyance, that it represents a large part of the capital outlay in our railroad, industrial and real estate undertakings. For this reason it is of the utmost importance that the most rigid economy be exercised in its use. By an economic design is meant a design wherein the cost of material and labor entering into the construction of said design will be a minimum. In other words, the writer considers a well designed structure one which will most efficiently perform its function with a minimum outlay of capital and the lowest annual maintenance charge.

One of the most important features of a material to be used in construction work, consists in the ease and simplicity, together with the safety and reliability, with which one member can be attached to another. In the case of wooden construction it is almost impossible to make a connection of one member to another with any degree of certainty and use ordinary factors of safety. In the case of reinforced concrete, or, more properly speaking, concrete reinforced with steel, where the joints are largely dependent upon the adhesion of the concrete to the steel, the question of connections is an uncertain problem. In structural steel, owing to its homogeneous nature and uniformity of strength, it is possible to mathematically determine the value of connections of one member to another with reasonable margins of safety and secure a perfectly safe structure. Owing to the importance of securing reliable connections of one member to another, it is perfectly natural that the type of connections used in steel structures should be one of the most important subjects to be considered in structural steel designs. It will be observed that the question of connections is, therefore, given very careful consideration in this paper.

The first iron and steel bridges designed by our American engineers were typically American. That is to say, our type of construction was radically different from that used by other nations. The question of cost was given the most careful study, and justly so, as the railroad companies which purchased these structures had a very difficult time to make both ends meet. In those days the rolling stock of our railroads was very light; the volume of traffic was very small, and the trains did not move over the railroads with the high speed of to-day.

The type of structure referred to is the pin-connected span. When first introduced it was built of any length ranging from 30 ft. upwards. It was very popular owing to the small amount of metal required in its construction, the ease with which its members could be transported over great distances, and the facility with which it could be erected. These bridges were built at a time when the science of building structures of metal was in its infancy. As a consequence most of the old-time bridges were built with very inferior details. Owing to the rapid increase in the weight of the rolling stock of the railroads, they were soon taxed to their capacity and unfortunately sometimes beyond their capacity. As a result it did not take long for these old-time bridges to develop imperfections and it soon became apparent that the pin-connected bridge was not the ideal type of structure to be used in every case.

* Paper delivered to the Western Society of Engineers, Nov. 8th, 1911.

The next step was the introduction of the plate-girder bridge and the riveted-truss bridge, and it soon became common practice to build plate girders for all spans from 20 to 75 ft. in length, and from 75 to 125 ft. various forms of riveted trusses, and spans over 150 ft. of the pin-connected type. In other words we began to follow the practice of European engineers in the building of our shorter span bridges.

Now, let us analyze why we departed from the old-time practice of building pin-connected bridges and substitute the use of the riveted bridges. In the first place the old time pin-connected span was used without consideration of span length. The shorter pin-connected spans, owing to their extreme lightness, the small moment of inertia of their tension members, poor lateral bracing, and generally inferior details, vibrated excessively under traffic. The fact that these small pin-spans were used out of the sphere which naturally belonged to them, led a great many engineers to abandon the pin-connected span almost entirely and of recent years we have adopted more extensively the use of the all-riveted span for our longer span bridges. It has occurred to the writer, however, that in many cases we have substituted riveted spans for our long span bridges where a pin-connected structure would have been preferable.

The ideal span to build would be one that is free from vibrations and without secondary stresses, but as this is impossible, the problem then is to select that type of design which has the minimum number of objectionable features. For an ordinary simple truss span there are four types of construction to be considered:

First, the truss with built up chords and diagonals and riveted connections throughout, or what is ordinarily called a riveted span. In this type of construction the span should be made as deep as good designing will permit. The dimension of the chords and web members should be made as narrow in the plane of the truss as permissible. By increasing the depth of the trusses the connections of the diagonals to the chords become smaller; the deformation of the truss under load becomes smaller and consequently the secondary stresses become smaller.

The problem of selecting the proper dimensions of the various members forming a joint requires a great deal of skill and judgment. In the first place the various members should be slender, so as to be as flexible as possible, in order to reduce the secondary stresses due to the bending of the member. On the other hand, with slender members it is exceedingly difficult to concentrate the rivets in the connections. This calls for the rivets to reach far out into the members; hence the use of large gusset plates. The longer the connection becomes, the more uncertain the action of the rivets, and therefore the more objectionable the connection. The size of the gusset plates may, in many cases, be reduced by connecting the main member to both sides of the gusset plate by means of an auxiliary connecting plate. By this means the rivets connecting the main member to the gusset plate take double shear and thus the number of rivets can be reduced in proportion.

The slenderness of members calls for compression members with small moments of inertia, and therefore they are not so economical as a column as one with a greater moment of inertia. In the case of tension members it means thicker material and, therefore, more waste due to deductions on account of rivet holes.

Thus we are confronted with the problem of selecting members having large dimensions of their cross-section in the plane of the truss, with the possibility of their connections being concentrated to a minimum, and, as a consequence thereof, of having large secondary stresses due to

bending of the connecting members. Or, on the other hand, selecting a cross-section with the least width possible, which in turn calls for small moments of inertia; that is to say, the members are not economical compression members, nor are they economical tension members, as the material becomes too concentrated. The great problem is, therefore, to know just where to draw the line in the selection of the various members.

In order to somewhat overcome the effects of the secondary stresses in riveted-truss spans, some of our specifications call for their partial elimination by lengthening and shortening the various truss members, amounting to the respective distortions due to dead load plus one-half the live load, and reaming of the chord splices, while the chords are assembled in a straight line, and then forcing them in their proper position before the connections of the diagonals to the chords are drilled or reamed. This is all right as far as it goes in the shop, but when the structure is actually being erected it is an altogether different proposition. If the chords were first riveted together and then put on their camber blocking before they were connected to the diagonals, these results might in a measure be obtained.

Before a long fixed span can be swung it is necessary to rivet all the tension splices in the chords, so that it is very probable that a large part of the refinement that was put on this work in the shop is lost in the field.

Second, the truss with built-up continuous chords and built-up diagonals, pin-connected throughout. The vertical posts and diagonals are connected to the chord by means of pins, which in the case of a continuous chord become very small, owing to the fact that the pins merely transmit the increment of the stress to the chords. It is sometimes found desirable to rivet such posts and diagonals, as in case of reversal of stresses in these members, in order to avoid the wear in the pin holes. In such cases the stresses to be transmitted to the chords are very small indeed; consequently the connections are small and, therefore, secondary stresses are also very small. This type of construction can be designed by making the chords sufficiently shallow in order to make the same flexible and the diagonals sufficiently wide in the plane of the truss, so that they are sufficiently strong to rotate upon the pin and overcome the pin friction when the structure deflects. It is believed that this type of construction has a minimum amount of secondary stresses.

The only objection to this type of span is that it weighs more than a span with eye-bars used as tension members, and that the tension chords must be spliced in the field before the span can be safely swung, which in many cases is very objectionable as in most long-span bridges it is desirable to make the span safe in the least time possible.

Third, the truss with the chords built up and made shallow in order to be flexible; diagonal eye-bars, pin-connected.

Fourth, the truss with bottom chords and diagonals made of eye-bars. While this type of construction is pin-connected throughout and theoretically articulated, the joints are actually more or less rigid, due to the friction of the bearing of the eye-bars on the pins. In order to reduce to a minimum, the secondary stresses due to pin friction, it is desirable to make the bars as wide as permissible and still not exceed the allowable bearing value of the eye-bars upon the pins.

It is extremely difficult to determine the amount of secondary stresses in a pin-connected bridge, due to the weight of the bridge itself, inasmuch as it is impossible to determine the frictional resistance upon the pins which the various members encounter in righting themselves, while the camber blocking is being removed and the span swung.

While the action of eye-bars in a structure is not perfect —that is to say, that bars have more or less secondary stresses—nevertheless, they are one of the safest articles used in the construction of a bridge. When we are using an eye-bar we can feel that we are using something about which our knowledge is reasonably complete. It seems to the writer, however, that it is the common practice of engineers either not to use eye-bars at all or else to use them rght up to the limit of their capacity as determined by full size tests. They seldom figure out what amount of economy could be obtained by using an eye-bar with a somewhat lower unit stress on the same basis that they use a riveted member. In the case of a built-up tension member, there is a large amount of material which is wasted, inasmuch as it does not enter into or carry part of the primary stress; namely, such material as is added to take care of the deductions from this section, necessary on account of rivet holes, and material added for lattice-bars, batten plates, etc. If they realized that they could add considerable material to their eye-bars and still use them with economy, they might not be so adverse to their use. This material added to the eye-bars would reduce the normal stress in the eye-bars to such an extent that the secondary stresses could be entirely ignored.

The vibration of pin-connected spans may be reduced in several ways. First, by making all of the members built-up, with, comparatively speaking, large moments of inertia in the plane of the truss; second, by making the eye-bars sufficiently wide so that their deflection, due to their own weight, will not be too great; third, by weighing down the bridge by means of a ballasted floor. The writer cannot help but feel that when we come to our longer span bridges, the pin-connected type bridge is the proper one to build. The main advantages of a pin-connected span with eye-bar tension members, are that it weighs less than other types of construction and can be built in the shop with extreme accuracy so that there is little possibility of encountering trouble in erection through faulty workmanship. Erection can proceed with greater rapidity than with the riveted span, and the writer believes that less skill is required in designing a pin-connected span than a riveted span.

Lateral Bracing.—There is a feature in our long span bridges which should be considered very thoroughly, and that is the question of lateral bracing for the compression chords. In the shorter span bridges the loads allowed for wind bracing are ample to provide sufficient material to take care of the actual wind stresses, and also to hold in alignment the compression chords. However, in very long span bridges, the question of providing sufficient lateral bracing for the compression chords to hold them in proper alignment, so that the compression chords will act in unison throughout their entire length and in reality form one compression member when considered in a horizontal plane, should be carefully considered. In this respect the lateral bracing, in addition to performing the function of wind bracing, also performs the same function that the lattice bars do to the individual compression members. However, in the case of an ordinary member the lattice bars connect continuous members, whereas, the lateral bracing must hold in alignment members which are not thoroughly spliced, and are, therefore, more liable to be out of true alignment on account of imperfect workmanship.

It is not an easy matter to determine the amount of lateral bracing which it is necessary to provide to hold the compression chords in proper alignment, owing to the fact that we have not made sufficient tests of large size compression members to determine just how much material is re-

quired to hold in proper alignment the main sections of a compression member.

This same question of uncertainty applies to the proper bracing of the top flange of our through plate girder bridges. The writer is well satisfied that a large number of our designers do not have the same margin of safety in the compression flange of their through plate girder bridges as they have in the tension flange. Some recent tests of plate girders show that the ultimate strength of the top flange is about the elastic limit of the material. In order to make the top flange of a through plate girder bridge the same strength as the bottom flange, we should have some formula to guide us in the proper proportioning of the top flange. A formula for this purpose can be developed only by a series of experiments. However, in the meantime it seems to the writer that we should apply our column formula to these flanges. Of course, the value of intermediate supports should be given proper consideration.

Another feature in our plate girder designs, which the writer is inclined to believe will cause our engineers some regret, is that they have not as a rule increased the thickness of their web plates in the same ratio that they have increased their flange areas. This is especially true of the long plate girder spans. When the large web plates are rolled at the mills the edges of the plate cool first, which causes the plate to become "dished." In order to eliminate this dishing or buckles in the web, it is necessary to put these web plates in the bending rolls until the buckles are eliminated. After this the plates are straightened for use. There can be no question but that there are heavy secondary stresses in all these large web plates. In addition to this the web plates are more exposed to corrosion than any other part of the structure and if there is any deterioration in this structure, the web plates will show the greatest portion of this deterioration.

In many cases stringers and the shorter span plate girders could be built not only better, but also cheaper, by omitting stiffeners altogether, except at end connections or bearing points and in cases where necessary on account of other connections, and putting a like amount of material in the web, thereby obtaining a much stronger web and adding some to the strength of the flanges.

It frequently happens that heavy portal or sway bracing is attached to the upper parts of bents, leaving the lower portion unbraced, and due consideration is not given to the bending which this portal or sway bracing might induce into the columns; the columns are merely provided with ordinary lattice bars below the portal or sway bracing instead of being provided with proper web plates or cover plates to transmit the shear to its proper destination.

Lattice bars should be eliminated where it is practicable, inasmuch as their function consists merely in holding members together, and they do not assist materially in transmitting the main stresses, whereas, if a solid plate were used it would form a part of the member as well as take care of any local shear that might be manifest.

In order to get accurate workmanship in large compression members, they should be so designed that they can be completely assembled in the shop before riveting. This practically means that even some of the smaller compression members should have lacing bars with at least two rivets at each end, in order to keep in proper alignment the members while they are being riveted in the shop. The larger members should have sufficient diaphragms to insure the proper amount of rigidity.

There is a tendency among engineers to over-rivet their compression and tension members to make the material act as a unit, and it often happens that the material is weakened by this means. Material should be used as it comes from the mills with as little labor on it as possible.

In many cases the specifications call for symmetrical sections, but do not mention the fact that the connections should be symmetrical or at least an equal number of rivets on each side of the centre line of the member.

Some engineers are inclined to lay down rules to others which they themselves are not following—for instance, in trough floor construction used extensively for track elevation purposes. These troughs are filled with concrete and become inaccessible for painting and inspection. The writer believes that much better results might be obtained by using I-beams and reinforced concrete decking on top of the I-beams with ballasted floor on top of the concrete. In this way the structural material is always accessible for painting and inspection.

In the designing of our mill buildings, especially where high speed traveling cranes are used, special attention should be paid to the proper distribution of the lateral forces induced by the traveling cranes throughout the building. In cases of this kind, the bottom chords of the roof trusses should be provided with a good lateral system extending the full length of the building, so that the lateral forces will be thoroughly absorbed throughout the structure.

Nickel Steel.—Of recent years some of our engineers have been advocating the use of nickel steel and other steels of high ultimate strength. Inasmuch as the modulus of elasticity of nickel steel is the same as that of carbon steel, the structures designed with these steels of high ultimate strength, where the unit stresses are from two and one-half to three times those used for ordinary carbon steel, the deformation and deflections will be from two and one-half to three times those of structures built of ordinary carbon steel. As the deformation of the structure increases the secondary stress also increases in proportion. What is more, even if the secondary strains have been rectified for the dead load, the deflections due to the live load will be much greater in proportion in structures of nickel steel than in those of carbon steel, for the reason that the weight of the live load in this case is much greater in porportion to the weight of the dead load than is the case where ordinary steel is used. In addition, the deflections caused by the passing of the live load over the structure are much greater owing to the increased unit stress employed.

For the above mentioned reasons, structures built of steel of high ultimate strength should be designed with the minimum secondary stresses. One of the worst features in connection with the use of nickel steel has been that some of our engineers have used carbon steel in conjunction with nickel steel. Take the case of a simple truss span, where the chords are made of nickel steel and the lateral bracing is made of carbon steel. The two chords are tied together by the lateral bracing forming one compression member, and any deformation which takes place in the chords due to the compression of the same must be borne proportionately by the laterals. This means that the lateral bracing may be stressed up to its elastic limit, while the chords themselves are not stressed beyond their usual requirements.

In stating that nickel steel and carbon steel should not be used together, is meant in such parts of the span that act in unison. For instance, there can be no objection to the use of carbon steel in a nickel steel structure for floor beams and stringers, or such members as act independent of the main structure, provided ample provision is made for the stringer connections to expand. These are points, however, which can be taken care of in the design of the structure.

Secondary Stresses.—The future development of our bridges depends upon the careful consideration and elimination, as far as possible, of the secondary stresses. It will be observed that in none of the various types of spans considered is it possible to eliminate entirely the secondary stresses in the chords. The secondary stresses may be reduced by the selection of the proper section for the diagonals and their attachments to the chords. Secondary stresses are developed in trusses through the connections of the lateral bracing and the floor system. In a through bridge the elongation of bottom chord produces an elongation in the bottom laterals, resulting in heavy secondary stresses in both the floor beams and laterals when they are attached to the stringers and intermediate points. In a deck bridge the top chord being in compression is reduced in length, while the bottom flange of the stringers is elongated more or less, for which reason the stringers should be provided with extension joints at the floor beams in order to avoid excessive secondary stresses.

To minimize the effect of secondary stresses in a truss, it is well to omit knee bracing and sway frames at intermediate panel points.

The main posts of a truss should be made the full depth of the truss wherever possible; in other words, bracing to increase the efficiency of posts and the use of sub-struts, materially increases the secondary stresses. Floor beams should be made deep and centrally connected to the posts. In order to avoid chord stresses to be transmitted to stringers, their end connections should be made flexible. This can be done by using a wide gauge of the outstanding leg of the angle connecting the stringer to the floor beam.

When a truss with subdivided panels is used the unit stress of the floor beam hangers should be very low so as to keep down the elongation in same, as the elongation of the hanger produces heavy secondary stresses in the chords to which it connects.

Aside from the make-up of the various members of a truss span and their connections, a great deal depends upon the type of span itself. Secondary stresses are very materially increased or decreased according to the type of the truss, whether it is a single intersection, a multiple intersection or a multiple intersection with vertical posts or without vertical posts.

Another source of secondary stresses in a truss is due to the fact that the bottom laterals are, as a rule, attached to the bottom of the post quite a distance below the bottom chord, so that the chord stresses in the lateral system must travel through bending in the post into the bottom chord. Besides this defect, laterals are not generally run in centrally with the chord, thereby inducing uneven distribution of chord stresses.

A DIAGRAM FOR SUPER-ELEVATION OF RAIL.

The engineering department of the Ohio Electric Railway, with Gaylord Thompson as chief engineer, has distributed to its roadmasters and section foremen a diagram showing the correct super-elevation to be used on the outside rail for various speeds and curves. A description of the diagram with the reproduction accompanying, is taken from the Electric Railway Journal. The curves on the diagram have been plotted from the accepted super-elevation formula. The limits which the company considers are proper for safe elevation and speed are shown by the irregular heavy black line. The speed of cars and elevation of outside rail must be inside this line. Thus, on a 4-deg. curve the track elevation, according to this diagram, should not exceed 4½ in. and the speed of the car should not exceed 40 m.p.h. On a 20-deg. curve the elevation should not exceed 6 in. and the speed 21 m.p.h. For a 50-deg. curve the figures are respectively 3 in. and 9 m.p.h. A note on the chart says that where line poles are spaced 100 ft. apart four times the number of poles passed in seventeen seconds is about the speed of the car in miles per hour. The broken line designated as one-half the speed at which cars would overturn on level track was computed by using the super-elevation formula in transposed form.

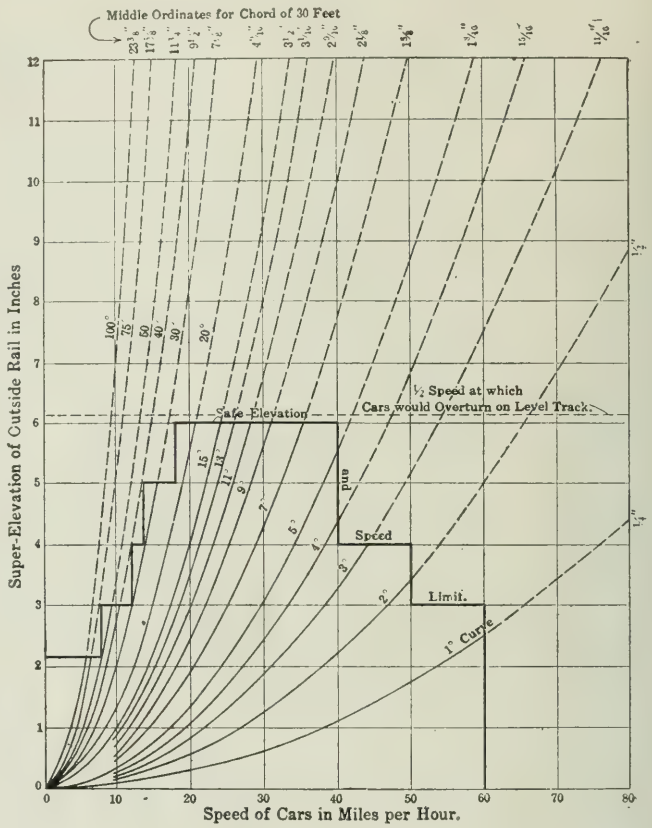


Diagram Showing Correct Super-Elevation to be Used on the Outside Rail for Various Speeds and Curves.

Trackmen, as a rule, are unable to determine accurately the degree of curve. They depend usually on their ability to compare by observation any given curve with one of known curvature. Hence to the diagram information has been added by which the trackmen can easily determine the degree of any curve. At the upper part of the diagram, at the ends of the lines representing the super-elevations of each curve, the mid-ordinates for a 30-ft. cord are given. These mid-ordinates are not wholly of assistance in determining the degree of curve and in checking the super-elevation, but are very valuable to check the curvature when rails are being bent to sharp curves with a roller bender.

The outer rails of all curves on the Ohio Electric Railway are being elevated to conform to the super-elevations given on the diagram, in general repair work and on new track construction. The diagram has been in use for several years.

ENAMEL PAINT FOR STEEL WORK.

Messrs. Wailes, Dove & Company's "Bitumastic" solution and enamels have been adopted for painting the gates and structural steel work in connection with the Panama Canal. Messrs. Wailes, Dove & Co. are represented in Canada by Machau & Hebron, Montreal.

THE UTILITY OF COKE OVEN TARS AS ROAD MATERIALS.*

The rapidly increasing use in this country of refined coal tar in the treatment and construction of roads and the fact that an immense quantity of coal tar will ultimately become available for this purpose through the installation of by-product coke ovens make it highly desirable to obtain accurate information as to the properties of coke-oven tars which are being produced at present.

While, in the manufacture of coal gas, the production of tar is absolutely unavoidable, this is not true of the manufacture of coke for metallurgical purposes. There are two general types of coke ovens in use at present, in one of which no attempt is made to recover the volatile products of the coal. This is the oldest form of oven, known as the "beehive," and is extensively used in this country to-day. Coke ovens in which the by-products are saved are now used to some extent in this country, and sooner or later will undoubtedly replace the old-style oven entirely, and thus increase our output of tar enormously. With the development of the road-tar industry, which promises to consume vast quantities of tar, and the necessity for refining such tars before use, the general adoption of by-product ovens is only a matter of time. What this will mean in the increase in tar production can be imagined from the fact that in 1908, out of a total of over 26,000,000 tons of coke produced in coke ovens, only a little over 4,000,000 tons were obtained from by-product ovens. About 22,000,000 tons of coke were, therefore, produced without recovery of the tar. As the average yield of coke per ton of coal was 66 per cent., this would represent the consumption of over 33,000,000 tons of coal. Upon the basis of a yield of 10 gals. of tar per ton of coal, it may be seen that over 330,000,000 gals. of tar were lost in 1908 which might have been saved. As the actual production of coal tar both from coke ovens and gas houses amounted to about 101,000,000 gals., it is evident that over three-fourths of our possible production of tar as a by-product was lost during that year. At a valuation of 2½ cts. per gallon, this means a loss of over $8,000,000. At a conservative estimate, the tar lost each year from non-recovery coke ovens is sufficient to build 9,000 miles of tar macadam road 15 ft. wide.

In order to determine the character of coke-oven tars at present being produced in the United States, it was first necessary to obtain samples from all of the known plants.

From a total of 31 manufacturers to whom questions were submitted 30 replies were received, but 4 of these reported their plants as not in operation. The remaining 26 furnished samples of their crude tar for examination and answered the questions in so far as they were able. Upon receipt of each sample the entire contents of the package were thoroughly mixed and a representative sample taken for analysis.

The statements relative to the maximum temperature to which the coal is brought during distillation indicate that two of the plants run below 970° C., that a total of 22 run not over 1,150° C., that 9 run from 950° C. to 1,150° C., and that only 5 run above 1,150° C. The maximum temperature of firing the retorts is, however, reported in most cases as being higher than the maximum temperature to which the coal is brought.

The maximum percentage of free carbon reported is from 16 to 24 per cent., but 17 manufacturers reported the maximum percentage of free carbon as being 12 per cent.. or under, and only 4 as 16 per cent. or over.

Analyses of the samples received were made, the work consisting in determining the specific gravity, free carbon, or organic matter insoluble in c. p. carbon disulphide upon a 15-minute digestion at room temperature, material soluble in carbon disulphide, percentage of ash, and percentage of different fractions obtained by distilling a 250 c. c. sample in a 750 c. c. tabulated glass retort with the thermometer so placed that the top of the bulb was level with the bottom of the juncture of the stem and body of the retort.

The gravities of the samples examined range from 1.133 to 1.214 and that the great majority are lower than 1.200. This in itself indicates low percentages of free carbon. The minimum percentage of free carbon was 2.73, the maximum 16.80, and the average for the 26 samples 8.38. Eighteen samples contained less than 10 per cent. of free carbon and 8 more than 10 per cent. About two-thirds of these products might, therefore, be considered as low-carbon tars and the other third as medium-carbon tars. The amount of ash in no case exceeded 0.16 per cent., and in most cases it was practically nil. This is, of course, also true of practically all gas-house coal tars. The percentage of water present varied from a trace to 10.1 per cent. by volume, but in only 3 instances did it exceed 5 per cent. It is of interest to note that 14 of the pitch residues, remaining after distillation had been carried to 315° C., were either soft or plastic —a condition which has seldom been noticed by the author in the distillation of gas-house coal tars. The amount of solids which crystalized or precipitated out of the different fractions was found to vary greatly.

Results were also calculated upon a water-free basis—i.e., the percentages are expressed in terms of the actual tar exclusive of water. Considering these products according to type, the tar produced by the Koppers ovens contained the lowest percentage of free carbon, the Semet-Solvay tars the next lowest, the United Otto next, the Otto Hoffman next, and the mixed tar from the United Otto and Rothberg ovens contained the highest percentage of free carbon. For the sake of comparison the minimum, maximum, and average percentages of free carbon for each of these types are shown in Table I.

Table I.—Percentage of Free Carbon in Coke-Oven Tars.

(Water-free basis.)

Type of oven.	Percentage of free carbon. Minimum.	Maximum.	Average.
Koppers	2.81	3.95	3.38
Semet-Solvay	4.04	9.00	6.74
United Otto	5.26	12.55	9.00
Otto Hoffman	8.62	14.69	1.216
Otto Hoffman and United Otto (mixed)	11.51	13.52	12.51
United Otto and Rothberg (mixed)	17.17	17.17	17.17

The percentages of various fractions for the different types of tars overlap to such an extent that no detailed comparison will be made. The maximum, minimum, and average total distillates to 315° C. for the different types are, however, given in Table II.

*Abstracted from a circular prepared by Prevost Hubbard, Chemist, U.S. Office of Public Roads, and issued by that office.

Table II.—Percentage by Volume of Total Distillate to 315° C. in Coke-Oven Tars.

(Water-free basis.)

Type of oven.	Percentage by volume. Minimum.	Maximum.	Average.
Koppers	30.5	36.0	33.3
Semet-Solvay	22.6	40.8	29.9
United Otto	25.6	38.5	32.6
Otto Hoffman	25.3	43.6	36.0
Otto Hoffman and United Otto (mixed)	19.9	32.1	26.0
United Otto and Rothberg (mixed)	26.9	26.9	26.9

From this table it is evident that wide variations exist in the relation of total distillate to pitch residue in the coke-oven tars produced in this country, and this is even true of different tars produced by the same type of oven.

Straight coal-tar road binders or refined coal tars are usually manufactured by subjecting the crude material to a process of distillation with or without steam or air agitation. Distillation is carried to the point at which the residuum remaining in the still has obtained the desired consistency at normal temperatures, and this involves the removal of certain of the more volatile oils present in the crude material. For use in construction work a soft and almost fluid pitch is often produced, and the consistency of this pitch is controlled by means of a melting point of float test. When the crude tar runs abnormally high in free carbon, it is sometimes mixed with crude water-gas tar before distillation. Water-gas tar contains a very low percentage of free carbon, and by properly proportioning the two a product is obtained, upon distillation, which does not carry more than the maximum limit of free carbon set by manufacturers. What the maximum limit should be is a much mooted question among those who have given thought to this matter. The governing considerations are: (1) What is the most economical limit from the standpoint of manufacture? and (2) What is the proper limit with regard to the utilization of the product as a road material? For a number of reasons, which it is unnecessary to mention in this circular, an excessively high-carbon tar is difficult to distill properly and, with other things equal, the lower the percentage of carbon the easier and shorter the distilling process. From this standpoint, therefore, by-product coke-oven tars are well adapted to the manufacture of road binders. Moreover, because of their low percentage of free carbon, they may be employed in a manner similar to water-gas tars, when it is desired to utilize a crude high-carbon tar in the production of a medium-carbon tar road binder.

In an ordinary road tar for use in construction work where free carbon is present to the extent of about 20 per cent., the proportion of total distillate, below 315° C., to pitch residue is approximately 1 to 4. Where this relation exists the pitch residue is hard and brittle. A residue which is soft or plastic is to be preferred, as it would indicate longer life during service, and where such a residue is present the proportion of distillate would naturally be lower for a given consistency, as the distillates may be considered as fluxes for the residues.

In conclusion it may be said that indications point strongly to the fact that by-product coke ovens will eventually play a most important part in the road-material industry. The future demand for economical bituminous road binders in the United States will undoubtedly exceed the supply, and this in spite of the natural increase in petroleum and asphalt road binders. If such is the case, the present loss of enormous quantities of tar, to say nothing of gas and ammonia, because of the use of beehive ovens, is a matter worthy of the utmost consideration on the part of all who are interested in the conservation of our resources.

WIND PRESSURE.

The report of the National Physical Laboratory, London, presented at the meeting of the General Board, contains particulars of the work carried out last year, and of work it is proposed to undertake during the current year. Dr. Stanton, in the Engineering Department, has continued his study of the lateral variation in the pressure of the wind at any instant over an area of considerable extent, by means of the comparison of the mean pressure record of Dines tubes connected in parallel with the corresponding record of a single tube. Six pressure tubes, 60 ft. above the ground, and 70 ft. apart from each other, were linked up to a recorder so constructed that the movement of the maximum index was proportional to the arithmetical mean of the pressures in the tubes. Another precisely similar recorder was connected to a cluster of six pressure tubes which was so arranged on one of the towers that the six orifices were enclosed in an area of less than 2 sq. ft. The assumption made was that at any instant the pressure in each tube of the cluster was the same, so that a comparison of the maximum readings of the two recorders during any interval of time gave the ratio of the maximum pressure attained at the position of the cluster to the maximum average pressure attained at the six distributed positions. For this work it was necessary to erect four auxiliary steel towers, each 60 ft. high, which were placed between the existing towers. Each of the 12 Dines tubes was connected by a pair of 3/8-inch lead pipes 250 feet long to the recorders in the observation hut. During the last three months of last year there were several favorable opportunities for making observations, and it is now considered that sufficient data have been obtained to enable a prediction of the wind pressure over an area of several thousand square feet to be made from observations at a single point in the area. There remains the investigation of the effect of the more or less exposed nature of the site on the lateral variation of wind force, and for this purpose it will be necessary to carry out similar experiments elsewhere. By the kindness of Sir John Wolfe Barry, permission has been received from the Bridge House Estates Commissioners to make observations on the Tower Bridge.

CANADA AS A CHEMICAL PRODUCING CENTRE.

The importance of the chemical industries of this country and the opportunity for the growth of their foreign business has been recently exemplified by a report which states that negotiations have been entered into between the British War Office and a large chemical manufactory in this country for the supply of acetone for ammunition explosives. Acetone is a by-product in the distillation of wood for the manufacture of charcoal and wood alcohol.

It is proposed to use the substance as a binder for cordite, which is composed of nitro-glycerine, in a similar manner to the use of kieselguhr, a porous earth that is used as a binder for dynamite.

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THE COST OF FIRE.

The fire losses in Canada for the first three months of the current year total $6,904,217, an average of $2,301,405 per month. This is equal to a daily loss of $76,310. In other words, $3,179 worth of property has been burned every hour since the new year dawned, or $53 every minute. This is an appalling fire loss, and little is being done to check such extravagant waste of capital.

The National Board of Fire Underwriters of the United States, continuing its plan of education on the need of better protection, issued an exhaustive classification of fire losses in 1909, showing why the insurance companies are forced to ask higher rates in America than in Europe, and why rates in America itself necessarily vary. Taking thirty of the largest cities of the United States, the per capita loss in 1909 was shown to vary from $1.36 in St. Louis to $4.55 in Kansas City. Higher per capita loss was shown in some of the smaller centres, like the city of Racine, where it ran to $24.29. The total annual fire loss is estimated at $200,000,000, and fire specialists go so far as to assert that $150,000,000 of this is waste from negligence or lack of precautions. The table of comparisons drawn up by the underwriters from consular returns in 1905, the only recent year in which statistics of the kind were gathered in Europe, showed an average loss of 61 cents per capita for thirty European cities as against $3.10 for 252 American cities. Taking the number of fires to each 1,000 of population here and in Europe, it was found to be 4.05 in the United States against .86 in Europe.

The annual average losses for six nations in Europe were compiled from records of varying years and years grouped, with this result:—

Country.	Annual fire loss.	Loss per capita. Cents.
Austria	$ 7,601,389	29
Denmark	660,924	26
France	11,699,275	30
Germany	27,655,600	49
Italy	4,112,725	12
Switzerland	999,364	30

Or an average loss per capita of 33 cents.

The fire loss per capita in the Dominion last year was $3.02.

In Berlin, where the losses amount annually to less than those of one moderately large fire in the United States, the excellent conditions are due to the attention paid to the methods of construction. Building police have authority to compel the use of iron and steel girders, fireproof stairways and roofing, heavy fireproof ceilings, and all details that may diminish the risk of conflagration.

Canada cannot claim to be making untrammeled progress until its fire record has been improved considerably.

INCREASED WATER FOR THE CHICAGO DRAINAGE CANAL.

The Board of Trustees of the Chicago Sanitary District have recently applied for a permit to increase the diversion of water from Lake Michigan, and, amongst many others, the Commission of Conservation of Canada protested strongly against such action. The Chicago drainage canal is now taking 4,167 cubic feet per second, and the request of the trustees was that this should be increased to 10,000 cubic feet per second. The

Commission of Conservation have issued a pamphlet embodying their protest, which was presented at Washington on March 27th. The reasons given why no increase should be made in the amount now allowed are interesting, and deserve wide publicity. Among other things, the statement is made that the drainage canal has already cost $62,000,000. Its advocates have insisted that there was no other feasible method of treating Chicago's sewage.

It is pretty clearly understood at the present time that the dilution method of disposing of sewage, as practised by Chicago, has proved a failure, for already the canal has silted up from deposits of slush, and this must be removed by dredging. Already ill effects are noticeable on the Great Lakes from the present diversion, for reports of the United States engineers show a drop of four inches in the lake's levels due to the canal. While it is undoubtedly true that controlling works at the foot of Lake Erie would preserve the mean level of the lakes, it is easily seen that the River St. Lawrence would suffer, since the water passing down the canal would be abstracted from the river.

There seems no good reason why the request of Chicago should be granted. In fact, there is every reason why it should not be granted. A great number of cities in Europe are purifying their sewage. Many cities and municipalities in the United States and Canada are doing likewise. Methods of sewage disposal have arrived at the stage where it is quite possible to secure a high degree of purification with a reasonable expenditure of money. The city of Chicago, therefore, should be compelled to treat their sewage so that the present canal will be able to take care of the effluent.

CONCRETE PAVEMENTS.

The interest in concrete pavements at the present time appears to be considerable. During 1910, in the United States, about 700,000 square yards were laid. Last year figures recently compiled show that about five times that amount, or approximately 3,000,000 square yards, were laid throughout the country. In Canada it is hard to say how much has been constructed the last two years. However, the amount has been comparatively small compared with the above. There appears to be little uniformity as to methods of construction, but this, however, will be adjusted as more pavement is laid and publicity given to the methods used. There are indications even now of standardization of certain of the methods. The main objections or difficulties with concrete pavements appear to be the white glare of the surface, dust, and lack of resiliency. The question of joints, both transversal and longitudinal, is not adequately settled, and there is discussion as to the use of one or two layers or coats in the construction of the pavement. Some engineers are using lamp-black, or a coloring matter, mixed with the cement, to tone down the concrete and give a grey color pleasing to the eye, and they claim good results, although there appears to be some little difficulty in securing an even color.

Expansion joints are the source of differences of opinion. Most engineers appear to favor the use of transverse expansion joints at intervals of about twenty feet, although a few use no expansion joints whatever. If it were possible to get along without transverse joints and preserve the pavement from cracks and breaks, it would undoubtedly be better, for the edges of these joints appear to be productive of much trouble. The corners soon chip off, and the continuous passing of vehicles gradually forms an unsightly depression. Where pavements have been laid, in some cities, the edges of the joints are protected with steel angles in order to prevent these depressions. It is an open question, however, as to the advantage to be gained by this. If transverse joints are employed, the best method would seem to be the use of a very narrow strip of soft wood, which could be withdrawn and the joint filled with bitumen or tar.

Longitudinal joints appear to be used, more on account of construction reasons. By the use of a longitudinal joint down the centre of the pavement it is much easier to screed and finish the surface; the difficulty of screeding the full width of street is manifest. These joints, however, are open to serious question, as they would appear to invite the formation of ruts.

The use of one or two layers or coats in the laying of the pavement is open to discussion. With the use of one course, the entire pavement is laid in one operation and with one mixture. The surface is formed by tamping and troweling, forming a coating comparatively smooth on the top. The two-coat method seems to be the most in favor, and, providing careful methods are used in construction, will undoubtedly give good results. The bottom coat is a leaner mixture than the top, the top coat being made of about an inch and a half, or two-inch wearing surface. To secure good results with this method the two mixtures must be laid almost simultaneously in order that the materials may bond.

There has been a good deal of concrete pavement laid in the United States and a little in Canada, which has been covered with a thin coating of bituminous material, applied hot, and sprinkled with a layer of fine gravel or stone screenings. The result of recent investigations by Professor Smith, of Michigan University, shows that the expansion and contraction of concrete is due, not, as commonly supposed, to the effects of heat and cold, but rather to alternate wetting and drying. If this be true, it would be logical to assume that the application of a waterproof coating to the surface of concrete pavement would save the use of expansion joints.

As concrete can be laid more cheaply than any other type of permanent pavement, since it forms the base of all permanent pavements, there appears to be a wide future for its use. By the provision of a higher curb it may be used temporarily and afterwards converted into a brick or asphalt pavement, the original concrete pavement furnishing the base of the new pavement.

EDITORIAL COMMENT.

In all the talk of heroism shown by the passengers on board the Titanic, most people seem to have lost sight of one part of the crew who, above all others, showed magnificent qualities of courage. Of the engineers on board ship, not one was saved, all remaining at their posts below deck until the vessel sank.

* * * *

The annual report of the Interstate Commerce Commission of the United States, just issued, shows that there has been an increase in the number of derailments due to defective track much greater than would be accounted for by the increase in mileage and volume of traffic. The report states that the construction of cars and locomotives is tending towards an ever-increasing standard of dimensions without a proportionate betterment of track condition. This is a state of affairs to which the railway engineer must devote immediate attention. There is no doubt that the weight of rolling stock and the speed of trains have increased in a greater rate than the improvement in rail design and roadbed.

A NEW GAS-ELECTRIC CAR.

The management of the Canadian Northern Railway have recently introduced on their lines a self-propelled car that bids fair to solve the problem of cost reduction on the branch lines. The car presents many interesting features to the engineer, not the least being the method of transmitting the propelling power to the wheels and low operating cost.

In general appearance the car is similar to the palace types, used behind a steam locomotive, but its mechanical construction, of course, is greatly different. In the front portion of the car illustrated in Figure 1, is contained the power plant which consists of an eight-cylinder, 550 r.p.m., 4-cycle, 200 h.p. gas engine of the V type, direct connected to an eight-pole, 600-volt, commutating pole, electric generator. The magnet frame of the generator is bolted directly to the end of the engine frame, and the outboard bearing is ring oiled and contained in a three-arm bracket. The engine base is of cast iron and is provided with hand holes fitted with clamp covers for the inspection of the main bearings, etc. The bore of the cylinder is 8 inches and the stroke 10 inches. The exhaust and inlet valves, the air starting check valves and the spark plugs are mounted in dome shaped cylinder heads which are thoroughly water jacketed and are secured by four large studs tapped directly into the crank case. The cylinders are provided with auxiliary exhaust ports which are uncovered by the piston at a point near the bottom of the stroke, allowing the major portion of the hot gas to pass out through a water-cooled valve.

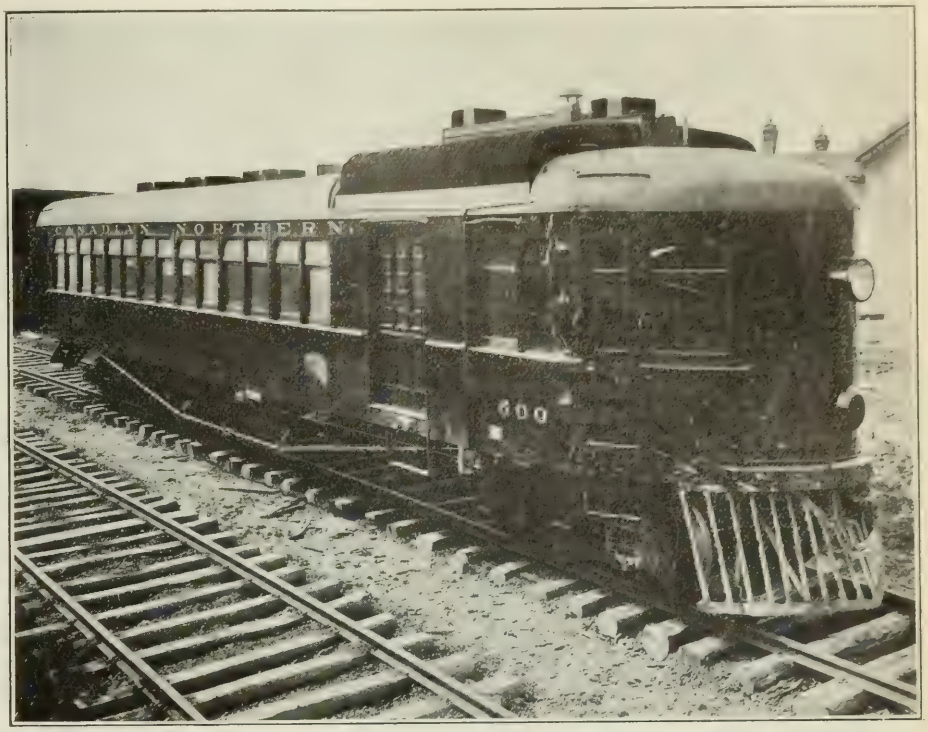
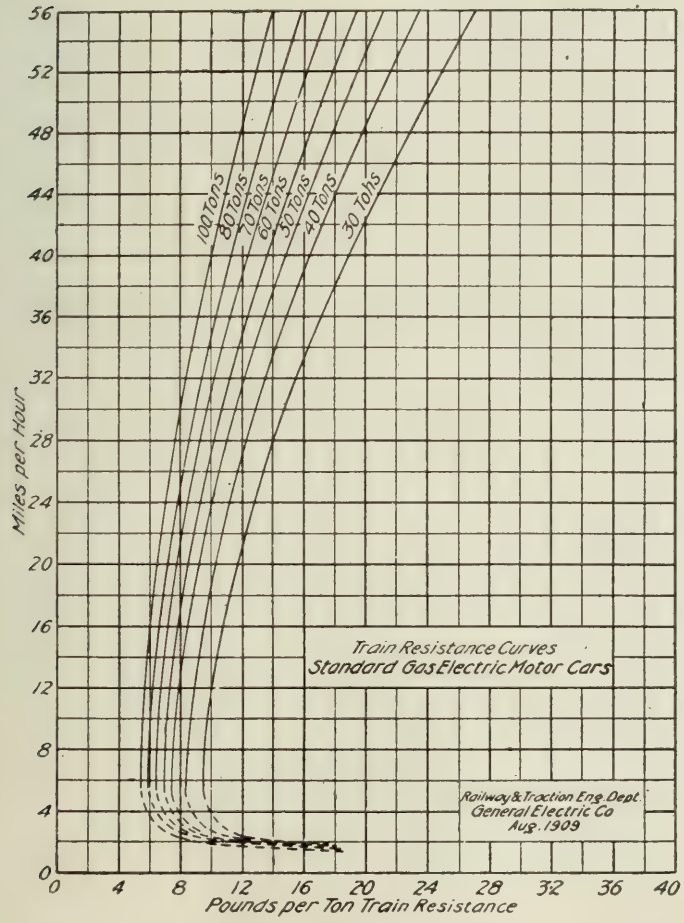


Fig. 1.—View of Car.



All the valves are operated by two cam shafts actuated by a single reduction gearing from the main crank shaft; one cam shaft being located on either side of the engine. The pistons are of the trunk type fitted with five cast iron rings. The lighting of the car is not dependent upon the main generator, a combined air compressor and lighting dynamo being included in the equipment for that purpose. The air compressor provides an initial charge for starting the main engine. This compressor has a displacement of 45 cubic feet of free air per minute, and the lighting generator has an output of 1½ kilowatts at 125 volts. A centrifugal governor is provided to insure a constant speed from the engine, of 600 r.p.m.

The forward truck of the car is provided with two standard 600-volt railway motors; these are of box framed, oil-lubricated, commutating pole type, and are mounted directly on the axles, and equipped with standard gears and gear cases.

The electrical control of these motors differs to a considerable extent from the method employed on an ordinary street car. By means of a special controller the driving motors are placed progressively in series and parallel; the voltage is governed by varying the strength of the generator field. This is accomplished by the movement of a single handle on the controller box. Separate handles are provided for reversing the car and for throttling the engine.

The car provides seating capacity for about seventy-five persons when the seats are arranged in a similar order to that of a steam railway carriage, and was built by the General Electric Company, at Schnectady. The Canadian General Electric, however, will build these cars for the Canadian market.

This car was recently given one or two practical working tests on the lines of the Canadian Northern Railway. The first trip was made from Toronto to Richmond Hill and the car was under the personal supervision of important officials of this railway. A second and longer trip was made on the following day; the line of travel was from Toronto to Trenton, a distance of 115 miles. During the latter trip about fifty gallons of gasoline were consumed and the operating expenses were about 18 cents per car mile.

At times this car reached a speed of 50 miles per hour, but it is declared by the manufacturers that under extraordinary conditions of roadbed the car can attain a speed of 75 miles per hour.

Owing to the success of this car it is probable that it will be the forerunner of others of a similar type.

TIMBER EXPANSION IN FLUMES; CAUSES AND REMEDIES.

By Godfrey Sperling.*

Several well-defined cases showing longitudinal expansion of timber occurred in flumes constructed during the year 1910 by the Centerville Mining & Milling Co., in Boise basin, Idaho. These flumes were built by contractors who had erected many similar structures in these placer-mining districts and it is particularly interesting that those built by the Centerville Co. were the first recalled wherein the expansion in a direction parallel to the grain was so marked as to be measurable and productive of such large stresses as to be more or less directly traceable to the failure of the higher portion of a long flume.

Experiments by the Forest Service at its various timber-testing stations indicate that the shrinkage of wood in a direction parallel to the grain is very small, and seems to be considered negligible. F. Roth writes: (Timber Forestry, Bulletin No. 10) "Since only an insignificant longitudinal shrinkage takes place (being commonly less than 0.1 in. per 100), the change in volume in drying is about equal to the sum of the radial and tangential shrinkage." That the shrinkage was appreciable in certain species of western soft woods has been brought to the writer's attention at various times by timber constructors. The cases referred to here, however, are the most marked and measurable expansion rather than shrinkage was here manifested.

A smaller straight flume 800 ft. in length showed an expansion of 0.75 ft., as measured from the movement of the mud sills at both ends, to which the last length of flume boards were spiked. This gives 0.083 per cent. expansion.

The timber for the flume box was logged and sawed during the months of July and August, 1910, from mature western yellow pine, and piled with drying strips in the sun. The timber selected was reasonably free from knots and sap-wood and contained little pitch wood. The flume was built about September 1; rains occurred in October and heavy snow fall, thawing and freezing, drying and soaking alternated during the winter until water was turned into the flume April 1. The expansion was measured after water had been in the flume one week and did not change appreciably thereafter.

The boards in the flume box were laid while dry, longitudinally, fitting tightly, end to end, and it can be assumed that the measured expansion very nearly represents that due to soaking and resoaking from air-seasoned condition to the saturation point. Had there been no opposing force to the free expansion of the timber, the measured expansion would represent the sum of expansion due to soaking and the thermal expansion. The latter at an average daily variation of the atmospheric temperature of 30 degrees F. would amount to about 0.1 ft. in 800 ft. of pine timber. Since the daily variation of temperature of the flume timber was about the same as that of the water which was nearly constant through the day, the thermal expansion can be neglected.

One of the forces opposing the free expansion of the flume was the resistance of the mud sills at either end set in firm soil about 2 ft. below the surface of the ground, with a retaining power of about 2 tons per sq. ft.; this would create a compressive stress in the flume box of about 75 lbs. per sq. in. Another opposing force was the resistance to longitudinal movement offered by the flume bents. These were built of square, sawed timbers, set on sills without anchors and without longitudinal diagonal bracing. On these bents the flume box was spiked. After expansion, these bents, near the ends of the flume, leaned toward the flume ends visibly. These bents offered perhaps less resistance to the expansion than that offered by the mud sills at either end. The total force generated by the expanding wood it is impossible to ascertain closely. It was certainly greater than the sum of these two opposing forces and continued to increase up to the saturation point. If we affect an analogy between the compressive stresses generated in a block of wood with its ends held fixed, and tending to expand, due to added moisture, to a block of wood under compression, we can assume that the attempted deformation due to moisture is proportional to unit stress generated. Taking 1,060,000 as the elastic modulas (Tremann, "Effect of Moisture on Wood," Forestry Bulletin No. 70) for resoaked pine wood, $\frac{S}{0.00083} = 1{,}060{,}000$. $S = 870$ lbs. per sq. in., this would represent the maximum unit compressive stress due to resoaking to the saturation point.

The main flume, 4,700 ft. long, was built during September, 1910, of similar material to the small flume. It was also subjected to the same exposure and water was turned in at the same time.

The movement of the mud sills at either end of this flume did not appear more marked than that of the shorter flume. Being built partly in curves, the compressive force in the flume box due to soaking had the effect of lifting the inner posts of bents on curves and actually did lift these posts from the sills on curves of the lower part of the flume. Bents as high as 36 ft. were observed in that condition carrying the entire load on the outer posts of the bents.

The dead load per bent of 16 ft. calculated from weights taken from dimensions of the flume was 3,600 lbs. and the live load of 10 second ft., the capacity of the flume with a cross-sectional area of 2.67 sq. ft., or 2,665 lbs. per 16 ft. bent. The total dead and live load was 6,265 lbs.

The distance from centre of bent to foot of post for a 36-ft. bent was 8.5 ft. Then by resolution let P equal the radial force acting at each bent at the flume box level.

$P = \frac{6265 \times 8.5}{36} = 1{,}480$ lbs. sufficient to lift inner post of a 36-ft. bent.

The radius of the curve at this point was 425 ft., the central angle for a 16-ft. bent was 2° 10′, tangential deflection was 1° 5′; therefore, the compressive stress in the flume box necessary to create this force P is $S = \frac{P}{\text{Cos. } 1° 5'} = \frac{1480 \text{ lbs.}}{.0184} = 78{,}200$ lbs.

* Transactions American Metallurgical Society.

The cross sectional area of the flume box is 80 sq. ins., giving a unit compressive stress of 980 lbs. per sq. in., or 110 per cent. of the unit stress arrived at in the smaller flume, and is, therefore, in close agreement therewith. The actual stress in the flume box, allowing for resistance caused by the bents which had no longitudinal diagonal bracing either, did not likely exceed 1,100 lbs. per sq. in. Some buckling, but no rupture was observed in the flume box of either large or small flume.

The relative small expansion noted at the ends of this long flume is accounted for as being thrown into the curves. It appears here that the stresses generated by expanding timber, due to moisture approximate those created in timber under compression.

The flumes were built for placermining purposes where the comparatively short life required and the lower first cost with higher maintenance was an economy and therefore justified the type of construction used. While these features were obtained, criticism might be made of the details of framing used. For instance, no longitudinal diagonal bracing was employed—only longitudinal ties and struts from bent to bent were used. In the latter (apparently an oversight) they were discontinued at one bent joint near the end of the highest part of the flume. It was at this point where the outer post buckled in the direction of the missing strut and all the joints on same level buckled and failed in the same direction, wrecking about 800 ft. of flume from 60 to 95 ft. high. The upper joints of bents, with flume box, dropped vertically and were pushed from 6 to 8 ft. into the ground.

It appears then that the wrecking of the flume was caused primarily by the expansion of the wood box due to soaking. The maximum forces possible from that source were acting and failure occurred at the weak point in the design. This experience shows that suitable provision for expansion of timber should be made where expansion parallel with the grain might be of material effect. More data on the subject of longitudinal expansion of various species of wood would be of help to engineers; nothing definite having come to the writer's attention.

The writer is indebted to Walter C. Locke, civil engineer, of Boise, Idaho, who had charge of the rebuilding of the wrecked portion of the flume, the most of the data concerning the flumes above described. In the rebuilding, an expansion joint allowing 6 ins. of longitudinal movement was used at the ends of curves, also a space of one-half inch was left between the ends of boards in the flume boxes.

PUBLIC UTILITIES IN EDMONTON.

The February report of these utilities presents a better appearance than that of January for the same civic departments. The municipal telephone system showed a surplus of $912.81. The telephone rentals amounted to $7,417.60; long distance tolls, $3.10; rental of buildings, $95, and bank interest, $119.07, making a total of $7,634.77, and less discounts, which amounted to $274.54, the revenue totalled $7,360. The maintenance expenditure amounted to $1,300.89; operation, $2,496.09, and interest and redemption, $2,650.44, making a total expenditure of $6,447.42. Deducting the expenditure from the revenue, a net surplus of $912.81 is shown. During February there were 109 services installed, and the average rent per 'phone was $2.06, and the cost and maintenance per 'phone $1.80, thus leaving a net revenue of 26 cents per 'phone.

The waterworks department showed a surplus of $459.45. The revenue, less discounts amounting to $1,233.43, was $14,348.43. The total expenditure for the month amounted to $13,888.98, which included a pumping plant charge of $6,373.78; operating and administration, $1,400; maintenance, $1,965.53; and interest and redemption, $4,249.47. The capital expenditure for the month amounted to $14,307.75, leaving a balance of capital account of $253,108.12.

The water pumped through the distribution system was 99,083,240 gallons, at a cost for pumping of 6.42 cents per 1,000 gallons. The revenue for sale of water was $9,527.48, and for frontage tax and miscellaneous $4,820.95, giving a total revenue per 1,000 gallons of 14.51 cents. There were 40,500,000 gallons of water supplied through meters and 58,583,240 supplied otherwise. The revenue from metered services amounted to $4,775.94, and unmetered services $4,751.54. The sum of $15,106.44 represents the month's profits from the operation of the electric light department. The total revenue for the month was $31,103.25, after discounts amounting to $1,120.82 had been deducted. The expenditure in this department amounted to $17,117.63.

The capital expenditure in the engineering department amounted to $819.85, and the capital expenditure on construction $52,108.57. The sum of $5,883.58 was expended on maintenance of boulevards, bridges, and sidewalks and sewers. The operating expenses amounted to $317.18, and the administration $3,166.42. The sum of $580.49 was netted from sundry items.

There were 6,957 tons of coal used at the power plant; the electric power plant boiler consumed 4,512 tons; pumping plants, 493; gas power plant, 383; and stocked, 1,569. The cost of alternating current amounted to $15,007.29, and the total output of alternating current was 544,339 kw.h. at 2.76 cents per kw.h. The gas plant alternating current cost $3,908.78. The direct current, steam driven, cost $5,995.73, covering a total output of 199,400 kw.h. at a cost of 3 cents per kw.h. The water pumping plant was supplied with $8,634.51 worth of power, which covers 119,424,310 imperial gallons pumped at a cost of 7.23 cents per 1,000 gallons. The total power-house expenses amounted to $28,231.22 on the north side, and $3,613.31 on the south side.

All these foregoing departments were operated on a paying system; such was not the case with the street railway, as an examination of the following will show.

The total revenue for the month was $26,033.76, which amount is made up as follows: Passenger receipts, $25,101.93; special cars, $207.75; hauling freight cars, $123, and advertising, $315.26.

The expenditure amounted to $28,111.67, out of which there was $3,027.32 expended on maintenance, $10,854 on operation, $8,856.93 for power charges, and $5,372.54 for capital charges. The total car mileage for the month amounted to 86,342.33 miles.

The deficit came to $2,077.91.

TOUR OF BRITISH ENGINEERS.

A party of engineers and engineering students from the universities, polytechnics and great works throughout Great Britain have left England on a tour of the United States and Canada. Landing at Quebec, they will cross the continent to Vancouver. They will then make their way through Washington, Oregon, and California, will visit all the chief attractions of the Southwest and return east through Colorado and the middle west, ending the tour with visits to New York, Washington and Boston.

The great railways, bridges, tunnels, steel works and latest buildings will all receive attention from the engineers, while other experts will examine financial and banking arrangements.

PRACTICAL FORESTRY FOR WATERWORKS.*

Most of the land on the protective areas which you control may be classed as agricultural land, brush land, sprout land, woodland, marsh land, and newly made land.

I believe most of you do not favor agriculture on your lands, as the plowed land is apt to be badly washed in the spring of the year. The snow, and the surface layers of the soil, melt under the spring rains before the frost has left the lower layers of the soil. This brings an objectionable amount of sediment into your reservoirs—and this is especially true where the land is heavily manured, as it must be to carry on successful agriculture. Therefore, the only agriculture possible for most of you is the annual cutting of hay lands. As the hay lands run out, their only agricultural use is for pasture, and finally, as they gradually deteriorate, they are reduced to brush land.

All of your brush land and any pastures which are yielding poor feed and small returns can probably be put to more profitable use by planting them to white pine.

Probably, in the case of those of you who control the largest protective areas, a large proportion of your territory is sprout land. Often such land has been bought by your companies with the privilege of cutting the timber reserved to the owner. For this land there is no treatment practicable except to let it grow up with perhaps the addition of a few hundred white pine trees per acre scattered in the openings between the bunches of sprouts.

I understand that the best practice to-day for the protection of watersheds involves the drainage of all swamps so that where these are wooded they are converted into what I have termed woodland. Where there are open meadows, the draining practically puts them in the same class as newly made land. By this term I mean to designate the land which you have made by excavating peat and mud from the beds of your reservoirs and piling it on the adjacent low lands. All of this newly made land, if well drained, is suitable for planting with white pine.

Woodland that is found in the protective areas of the waterworks of New England cities and towns consists largely of sprout hardwoods often reinforced in the older stands, to some extent, by a natural understory of hemlock or of mountain laurel.

In many cases the prevailing popular impression that it is a good thing to burn over, every year, hardwood land, and even pine land, has been further strengthened in the minds of waterworks men in their effort to keep the hardwood leaves out of the reservoirs. The damage that burning over the woods every year causes is not readily apparent to men whose chief interest is not in the woods. They fail to notice that the quality of the woods as a timber-producing machine is lowered each year, and that the water runs off quicker, year by year, bringing a larger and larger amount of silt into the reservoirs. The proper solution of the leaf nuisance lies not in annually burning the leaves, but in cutting away some of the hardwood trees along the edge of the reservoirs and planting white pine, Douglas spruce, and hemlock to catch the leaves. The softwood trees do not make an objectionable amount of litter in the water and their dense evergreen foliage serves to keep the hardwood leaves from blowing into the reservoirs.

In managing your woodlands on forestry principles you have the advantage over all other forms of ownership in the fact that neither the taxes on the land nor a high interest rate are really chargeable against the forestry work. If the land were bare, and kept bare, the water companies would still have to pay taxes on it in order to protect the quality of the water. Such large stable public service concerns can borrow money at an interest rate that is far more favorable than that of any other forest owner except the State. You must also maintain patroleum to keep your watersheds from pollution These men can serve without additional expense as a fire patrol, to detect, report, and extinguish forest fires. You have men on your summer pay-roll whom you want to keep with you. By giving them a job of cutting cordwood, by the cord, you can help them without raising the cost of improving your woodland. Your holdings must be relatively near large cities. That means abundant labor, cheap transportation, and an unlimited market for your products. There is no owner better situated to practice forestry than the water companies and the municipally owned waterworks.

Hardwood land does not retain water so well as softwood land. The softwood trees, by shading the ground all winter, retain the snow better. Their foliage keeps the warm air under them from cooling as quickly or as much as it does in the hardwood land. The mat of fallen needles on the ground keeps the frost out of the soil. Their dense foliage keeps the wind and sun from drying off the winter's accumulation of snow at the top. When a rain or warm thaw comes, the snow melts off at the bottom and the water sinks into the soil gradually, to be slowly added to your water supply through springs instead of rushing down over the surface all at once in spring, at the very time when your reservoirs are already overtaxed by flood waters from agricultural lands farther upstream. Hardwood trees evaporate from their foliage far more water during the summer than a similar area of softwood trees.

Of all the softwoods, white pine is the most profitable to grow in this region. From the time that a plantation first reaches a commercially marketable size at from twenty to twenty-five years of age it does not cease to yield an annual increase in its money value over that of the year before of over eight per cent. until it is fifty years old.

For this reason it is desirable to plant white pine as much as possible wherever planting is advisable. It is also desirable to replace the hardwoods by pine as quickly as possible; all the more so, as the white pine is not subject to attack at all by the browntail moth and in pure stands it is not damaged by the gypsy moth.

It will pay you to market much of the smaller material as thinnings, and concentrate the growth of your hardwoods in the best specimens until they are ready to be made into saw timber. Then underplant the open growth of hardwood with white pine seedlings a couple of years before making the final cutting of the old hardwood. When the old hardwood is removed you have a pine plantation already started which only needs the filling of a few blanks where the small pines have been killed and a small amount of brush cutting in about three years, and six years later, to leave it in good condition to grow until it is thirty years old.

There is only one spacing of white pine trees that is commercially practicable and that is about six feet apart each way. If they are planted closer than that they soon become too crowded, and long before the material which must be removed in a thinning has any commercial value they become too spindly and stunted to grow at a profitable rate. The expense of close planting is also enormous. If white pine is planted at a greater distance apart than about six feet it grows limby and bushy and is subject to great damage by the pine weevil. Plantations set out six feet apart each way grow straight and with small knots at a

* A paper read by Ed. S. Bryant, Consulting Forester, Boston, Mass., before the Boston Society of Civil Engineers, and printed in the Journal of the Association of Engineering Societies for June, 1911.

maximum rate until they are about thirty years old, when they begin to be crowded. At that age, however, the trees which must be removed are large enough to make saleable cordwood.

To sum up, therefore, I would advise you—to keep out fire from your lands, to plant pine along the shores of your reservoirs and streams, to thin your older stands of hardwood and underplant them with pine before finally cutting them, and to plant up with pine all open areas that are not yielding a fair return. You can both make money by growing timber and at the same time improve your catchment areas.

PORTLAND REGRADE OPERATION.

Eastern cities may well look to some of their western sisters for progressive ideas in civic improvement.

It is well known that Seattle, Washington, has in recent years veritably remodeled itself. From a city of steep hills she has been changed to one of gentle grades. This great project was eminently successful, largely because of the use of high-grade modern electrical and mechanical hydraulic apparatus.

Portland, Oregon, two hundred miles to the south, noticed the miracles being worked in Seattle and is now following suit by hydraulically reducing an abrupt prominence within her limits, known as Goldsmith's Hill. Because of the satisfaction given by the motors used to operate the pumps which washed the hills of Seattle into the sea, these same motors were later taken to Portland, where they are now being used to drive the pumps in the regrading there. The same successful performance obtained in Seattle from the motors is being experienced in Portland.

Fig. 1.

Like all properly engineered projects, the Portland regrading operations have gone through without disappointments. Nothing has been left to chance; every detail of the work was fully considered before operations began, practically insuring the success of the undertaking. The pumping units, including pumps and motors, were selected because their fitness for the work had already been demonstrated at Seattle.

The composition of Goldsmith's Hill is especially gravelly. The streams, therefore, are directed by huge nozzles so as to undermine the lower part of the bank, and the weight of the material above brings down the sand and gravel from the working face. From here it is washed through the sluice way into Guild's Lake, as shown in Fig. 1.

The trestle supporting the sluice through which the debris is conducted to the lake also supports two 18-inch pipes carrying the water pumped from the same lake. Fig. 1 is a general view of the site, showing how far the work had progressed by April 27th, 1910. The trestle is shown extending through the old Lewis and Clark Exposition grounds to Guild's Lake, where the fill is being made.

Fig. 2.

Fig. 2 shows Goldsmith's Hill from the corner of Raleigh and Twenty-ninth Streets on March 16th, 1910, before operations on it began. By November 3rd following, work was well under way, as is shown by Fig. 1. It might be mentioned that in some places the height of the bank to be reduced was 140 feet.

The pump house, a temporary structure, of course, is located near the lower end of the trestle. Its foundations were laid in the bottom of the lake at low water before any filling had been done. Now, however, the pump house is in the middle of a filled tract of several acres.

The contractors, the Lewis-Wiley Company, are carrying on the work day and night with no interruption except for Sundays.

It is expected that by the spring of 1913 the so-called Goldsmith's Hill will be no more and that its site will be suitable for no less than 300 residences, while the operation will reclaim to the city several acres of land from Guild's Lake, half a mile away. The project is, therefore, serving a two-fold purpose.

The motors are of Westinghouse make and rated at 650 h.p., 690 r.p.m., 2,300 volts, 2 phase, 60 cycles. Each is direct connected to two Worthington five-stage turbine pumps. The pumping service is amplified by the addition of a booster unit consisting of a Worthington volute pump directly connected to a 900 h.p. Westinghouse induction motor.

The pumping plant is capable of supplying 500,000 gallons of water an hour at a pressure varying between 200 and 300 lbs. per square inch, according to the demand.

Electric energy is supplied by the Portland Railway Light & Power Company's plant.

A NEW USE FOR SEWAGE WASTE.

Distillation of dried sediment from sewer water has been found by Prof. Honig to yield gas, as with coal or peat, and Brunn, Austria, is about to try this novel method for obtaining a supply of illuminating gas for the town. The heating value is claimed to be even greater than that of coal gas.

THE DESIGN AND MANUFACTURE OF CONCRETE PILES.

In a paper presented at the eighth annual convention of the National Association of Cement Users, Mr. Robert A. Cummings stated that all concrete piles of the cast-and-driven type must be reinforced with longitudinal rods, on account of the method of handling them by a line from the pile-driver fastened at or near the butt. Consequently, the pile has to sustain its own dead weight by being raised, as well as shocks and impact against obstacles, before reaching its position in the leads of the pile-driving machine. For this reason the pile must act and be designed as a beam capable of supporting its own dead weight and resisting outside shocks. The ratio of the depth or thickness of the pile to the unsupported beam length determines the tensile and compressive stresses and deflection that result from such handling.

It has been observed that when handling a pile of this type it rarely fails from compression in the concrete, but cracks are usually discovered on the tension side. These cracks may be accounted for, Mr. Cummings said, by the slipping of the usual longitudinal rods used in the concrete while the pile is being hoisted. While such cracks are not sufficiently serious to condemn the pile, they may affect the permanency of the reinforcement. In order to overcome this defect the author recommends that all longitudinal rods should be anchored at the ends, those at the butt opposite each other being bent over into a loop and welded together, while those at the point should be all brought together and electrically welded into one piece. Twisted and deformed rods are advantageous for longitudinal reinforcing, as their allowable bond stress is higher than that of plain rods.

The uniform circumferential spacing of longitudinal rods is very important, in Mr. Cumming's opinion, because any side of the pile may be subjected to tensile stresses, and whichever side is in tension, there must be sufficient steel in position to take the strain. The circumferential spacing of the longitudinal rods may be secured by means of a special spacing device placed at intervals of about 5 ft. throughout the length of the pile. The hooping of the concrete adds greatly to its ability to resist axial loads. Therefore, longitudinal reinforcing should have a helical wrapping of wire throughout the length of the pile, the pitch of which must not exceed 3 in. This wire wrapping assists in taking care of diagonal stresses resulting from the handling of the piles

Practical experience has shown that the butt end of the pile which receives the impact of the hammer should be especially reinforced. This has been done by means of a special reinforcement consisting of a unit cage of flat bands, held 2 in. on centres by a spacing bar for a distance of 2 ft. In the plane of each band a flat wire spiral is fastened to the cage. The embedment of this unit cage in the butt of the pile forms a resilient cushion to receive the impact of the hammer. In no case, in the driving of thousands of piles with this cushion, has the butt itself been broken.

Methods of Driving.—Piles of the cast-and-driven type are handled and driven by means of an ordinary pile driver. The ability to vary the fall of the drop-hammer is of great utility in overcoming the variable resistances to be met with in the driving. It has been found advisable to increase the weight of the ordinary drop-hammer as compared with the weight of the pile in the ratio of 2 or 3 to 1, so that the weight of the drop-hammer for driving the concrete piles will vary from 7000 to 12000 pounds.

Steam hammers are not as efficient or desirable for driving concrete piles as are drop-hammers. This last has been shown in a test made between a No. 2 Vulcan steam-hammer and a heavy drop-hammer, under the same conditions, using the same kind and size of concrete pile. The heavy drop-hammer did not break a single pile, whereas the steam-hammer broke several below the cushion. Further, the steam-hammer did not drive as many piles in a given time as did the drop-hammer.

The following explanation is offered by the author, as it applies also to the driving of the heavy steel casings or cores used in the making of the cast-in-place type of pile. He states that the limited fall (3 ft.) and light ram (3000 lb.) of the steam hammer, while delivering twice as many blows per minute as the drop-hammer, loses a large part of its energy in overcoming the proportionately greater inertia of the pile, steel casing or core. He states that an analytical treatment by Mr. Barton H. Coffer, M.E., of New York, confirms and justifies the practice of using hammers as heavy as 12,000 lb. for driving concrete piles, and, in his opinion, if penetration is to be the gauge for measuring the supporting power of a pile, the ratio of the weight of the hammer to the weight of the pile or core that is driven must be taken into consideration.

Manufacture.—The procedure in constructing cast-and-driven piles commences with the preparation of the molding bed. This, of course, will vary with the site, but it is desirable to select a flat and convenient location near the place of driving. It is very important that the bed shall be stable, so that the settlement due to he weight of the piles may be avoided. Where the ground is soft and yielding 2 × 4-in. pine stakes 3 ft. long, pointed at the ends, are driven to a solid bearing. These stakes are located at intervals of about 4 ft. in each direction and the tops cut to a uniform level. Then 4 × 4-in. pine sills are toe-nailed to the top of the stakes in longitudinal rows about 4 ft. on centres. Upon these sills a 2-in. solid wooden floor is placed, which forms the moulding bed. It is desirable that this bed shall be uniformly level to receive the forms for the piles.

The forms are made of two pieces of 2 × 8-in. dressed pine battened together and placed on edge to form the sides of the pile. The bevels or angles for tapered or octagonal piles are made by placing loose pieces of bevelled wooden strips at each end of the form. The steel reinforcement is delivered on the work in factory-made-units, so that it can be placed in the forms at once. When a reinforcing unit is suspended and centred in position, concrete of a wet consistency is depositeed and carefully puddled. As soon as the concrete of a pile has solidified, the forms are stripped and used for making other piles. The number of forms required will vary with the quantity of piles to be made and the prospective salvage in the lumber.

The curing of concrete in the normal manner delays the driving of the piles for a period of not less than three weeks, although a greater length of time is desirable, especially in cold and damp weather. Therefore, unless a stock of cured piles is always on hand it frequently occurs that this type of pile cannot be used at all, and resort is had to the use of the cast-in-place type. This practice is open to question on account of the inability of plain concrete to resist even moderate tension. In fact, it is almost axiomatic that all concrete piles must be reinforced. Every concrete pile is subjected to strains that induce very serious tensile stresses in the pile. Such stresses may result from superimposed loads or a lateral strain from the soil. Further, the making and storing of concrete piles for use at any time necessitates a large financial investment.

In order to avoid the above-mentioned objections, the writer has adopted the method of steam curing cast-and-driven piles. This enables such piles to be made and driven within 3 or 4 days and places the speed of driving on the same basis as that of the cast-in-place type.

The means used for steam curing will vary with circumstances, location of the work, speed required for delivery of the piles, the number needed, etc. During the past winter the writer has used concrete piles made and driven within 10 days, and as a result of this experience confidently recommends that such piles can be made, cured and driven immediately.

On this work the piles were allowed to set in a normal manner for 5 or 6 days, and were then gently hoisted from the moulding bed by a derrick, using an equalizing spreader and bridle, the chains of the bridle being fastened so that the pile was balanced. They were then placed in stacks of 25 or 30 and separated from one another by wooden blocks, particular attention being given to securing a solid bearing for each pile.

A light wooden shed, practically steam tight, was built entirely around the stack of piles. The steam was conducted direct from a boiler through a 1-in. pipe to three branch openings inside the shed. The steam pipe valve was opened and the piles were exposed to live steam for two or three days, when they were found to be ready for driving. On being first exposed to steam, the moisture condensed on the surface of the piles and remained until absorbed by the concrete when the temperature of the steam was reached. This steam treatment should be distinguished from heat applied indirectly or baking, in accelerating the set and hardening the concrete. The writer sees no reason why boiling water should not be used for the same purpose if the conditions are favorable for adopting this method. Precautions should be exercised in making sure that the concrete has solidified and that it has received its initial set before its exposure to steam treatment.

Attention is directed by the author to the publication of the tests of the Structural Materials Laboratory of the United States Geological Survey, an abstract of which is published in the Engineering Record of March 16, 1912, wherein it is conclusively shown "that a compressive strength considerably (in some cases over 100 per cent.) in excess of that obtained normally after aging for six months may be obtained in two days by using steam pressure for curing cement mortar."

BUILDING AND MUNICIPAL WORK IN WELLAND, ONTARIO.

Building Permits, 1912.

	Number of permits.	Total value of permits issued.
January	6	$ 7,735.00
February	8	8,615.00
March	16	34,870.00
Total for the three months	30	$51,220.00

The building conditions and general trade prospects show signs of great activity for this year. During this month the council let contract to pave two miles of the main streets, work to commence on the first of May. The street railway are making preparations to extend their lines on West Main, North Main, East Main and South Main immediately the weather is suitable. These extensions will exceed four miles of new track.

WATER METERS FOR REDUCING WATER WASTE.*

By F. H. Ruthrauff.

As to the effect of installing water meters at Decatur, Ill., I simply state the facts as I have found them during my 22 years' experience in the Water Department in Decatur.

The first five years I served as water inspector and worked faithfully in an effort to stop the waste, which was enormous, due to carelessness on the part of the consumers and to defective plumbing. In 1896 I employed four assistants, with the avowed intention of stopping all leaks. I again went over the city in 1898 with four assistants. I had citizens by the score brought into our police courts and prosecuted them for wilful waste.

After about five years' labor along this line I began to get discouraged. I found that a great many of our citizens believed we had an inexhaustible supply of water, and could not see any good reason why I should be so extremely anxious about this matter.

Consequently, I began to look for some other plan, believing that if this waste were allowed to continue, taking into consideration our rapid increase in population, we would in a short time find our supply short, or be at an unnecessary expense for additional machinery, mains and enlargement of our reservoir and filter plant in handling water merely to be wasted.

In 1901, I recommended to the council the adoption of the water meter on all services, but no action was taken. Again in 1902 I urgently recommended the same plan, and was then ordered to have all livery stables, hotels and laundries install meters. In the spring of 1908, the council ordered all services metered by July 1, 1908. The results are as follows:

April 31, 1904, the end of our fiscal year, we had 2,112 services recorded; five consumers for each service gave us 10,560 consumers; 987 of these services were metered. (There was no record kept of water pumped prior to 1903.) However, with 10,560 consumers, 4,935 of them metered, there was pumped for this year 1,023,180 gal., which gave us a per capita consumption of 266 gal.

For the fiscal year ending April 30, 1911, we had 4,939 services in use; 4,933 of them being metered. (The six services unmetered are large consumers.) This gives us, on a basis of five consumers to the service, 24,695 consumers. There was pumped during this year 1,124,212,338 gal., which is 100,749,158 gal. in excess of that for 1904.

With an addition of 14,135 consumers, we now have a per capita consumption of less than 125 gal. (as against 266 gal. in 1904). It is my belief that if the six consumers previously mentioned were metered, this consumption would be less than 100 gal.

We have accomplished by the enforced use of meters at least a 30 per cent. reduction in the average householder's bill. Under the old flat-rate system a seven-room modern house would cost him $17 per year, and under our present system the yearly bill should not exceed $12. We have also cut the per capita consumption from 265 gal. to 125 gal., saving an unnecessary pumpage of 1,270,928,175 gal. each year.

* Abstract of a paper read at the annual meeting of the Illinois Water Supply Association, March 5-6.

In describing the Dionic Water Tester in last week's issue of The Canadian Engineer we omitted to mention the fact that the agents in Canada for this instrument are Messrs. Vandeleur & Nichols, Dineen Building, Toronto.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS.

The American Transportation Question. By Samuel O. Dunn, editor of the Railway Age Gazette. Published by D. Appleton & Co., New York. Cloth; size, 5 x 7½; 209 pages. Price, $1.50 net.

This volume is a compilation of a number of recent addresses by the author in his course on Transportation at Northwestern University, and includes additional chapters on the regulation of railways and inland waterways in their relation to rail transportation. The first two chapters cover the fundamental principles of rate making. Railway valuation and profits occupy two chapters, and embody a sane and sound exposition of this phase. Throughout the volume the three important factors of the transportation problem, namely, rates, service and financial return, are not considered as separate and unrelated elements, but as closely inter-related problems. One would gather from the volume that the author thinks it highly desirable that the Interstate Commerce Commission should confine their activities to rate regulation.

Applied Methods of Scientific Management. By Frederick A. Parkhurst. Published by John Wiley & Sons, New York; Canadian agents, Renouf Publishing Co., Montreal. First edition. Cloth; 6 x 9. 326 pages, including index. Price, $2.00.

The main portion of this work appeared in a series of articles in Industrial Engineering during the year 1911. An appendix contains much new matter which was not included in the original. Many instructions and forms, which show substantially the medium employed to incorporate the principles of the science of management, into an efficient organization suitable for plant under the specific conditions illustrated, are given. The author states that he believes in adapting all details to meet each existing condition as found, and that an existing plant should be developed to its highest possible efficiency before making large outlays for extensive alterations or additions. This volume is a decided addition to the already extensive list of books dealing with scientific management, for theories and generalities have been avoided and the subject treated from a practical point of view, intensified by the many years of experience of the author along these lines.

Tests of Columns. An Investigation of the Value of Concrete as Reinforcement for Structural Steel Columns, by Arthur N. Talbot and Arthur R. Lord, has just been issued as Bulletin No. 56 of the Engineering Experiment Station of the University of Illinois. Price 25c.

The bulletin gives an account of the investigation of the strength of a type of column which has been used recently in the construction of reinforced concrete buildings. Structural steel angles are tied together by bent plates, making a form known as the Gray column, and this steel structure is itself filled with concrete and covered with a shell of concrete for fireproofing purposes. Such a column requires less space than the ordinary reinforced concrete column. Whether in such a column the steel and the concrete act together to give a strong stiff column has been a matter of some doubt. In the investigation described, tests were made on unconcreted steel columns of various lengths to determine the strength of the steel columns and the effect of length upon strength. Tests were then made on similar columns filled with concrete. This enabled the action of the steel and of the concrete to be compared. The breaking loads were determined and the shortening of the concrete and of the steel was carefully measured. Tests were also made upon columns having a fireproofing shell and upon columns reinforced with spiral hooping. It was found that the column strength is approximately equal to the ultimate strength of the steel column of the same length plus the strength of a short concrete column of the same quality of concrete. For loads approaching the ultimate, the shell of fireproofing concrete clung to the column without spalling. The columns tested possessed the qualities of a good structural member and seem adapted to more general use in building construction. Copies of Bulletin No. 56 may be obtained from the European sales agents, Chapman & Hall, Ltd., 11 Henrietta Street, Covent Garden, London, W.C., England.

Starting Currents of Transformers, with special reference to transformers with silicon steel cores, by Trygve D. Yensen, has just been issued as Bulletin No. 55 of the Engineering Experiment Station of the University of Illinois. Price, 25c.

This bulletin gives the results of tests upon five commercial transformers, showing the rush of current upon closing the primary switch, at various points of the impressed e.m.f. wave, and with a residual magnetism of various magnitudes, with the secondary open-circuited. The phenomenon is illustrated by means of oscillograms. Three of the transformers tested are of recent manufacture, with silicon steel cores, and the other two are old types. The test shows that the starting current for the silicon steel cores may rise to more than seven times the full load current, while for the old types the maximum rise is not above four times the full load current. The complete theory is given for calculating the starting currents, also for calculating a resistance or aircore inductance for limiting the starting current to safe values. In the appendix is recorded a series of tests on the permanence of the residual magnetism of transformers, and it is shown that under ordinary conditions the residual magnetism does not decrease with time, while the decrease due to severe shocks is very small. Copies of this bulletin may be obtained from the European sales agents, Chapman & Hall, Ltd., 11 Henrietta Street, Covent Garden, London, W.C., England.

Constructing Concrete Porches. By A. A. Houghton. Published by the Norman W. Henley Publishing Company, New York. Paper; 5 x 7; 60 pages. Price, 50c.

This book forms No. 9 of the Concrete Worker's reference books, and is explanatory of the construction of monolithic concrete and concrete block porches together with the moulding of columns, balusters, lattice and railings, as well as plain and reinforced types of porch floors. Many details of moulds and ideas that are not covered by patents, such as may be easily and cheaply constructed, are given.

Practical Chemistry for Engineering Students. By A. J. Hale; published by Messrs. Longmans, Green & Co., London. Canadian agents, Renouf Publishing Company, Montreal. Size, 5¼ x 7¾; 192 pages, including index, many tables and figures. Price 90c.

This treatise is intended for the use of students in the various branches of engineering. The program of practical exercises makes no claim to have introduced any fundamentally new principle. Its distinctive feature is the teaching of the subject with a bias towards the use of materials familiar in constructive industry. This is entirely proper and will be much more successful in arousing the interest and fixing the attention of the students. This manual is intended to give a little broader outlook on chemistry for the engineer than the mere dexterity in making analyses.

Precise Calculations of Pipe Drain and Sewer Dimensions. By. C. E. Housden. Published by Messrs. Longmans, Green & Co., London. Canadian agents, Renouf Publishing Company, Montreal. Size, 5 x 7¼; 53 pages. Price, 75c.

This little volume is called the "Precise and Therefore Economic Calculation of Pipe Drain and Sewer Dimensions for use in Water Supply, Drainage, etc.," and is a collection of tables based on the author's experience in this subject. Some of the tables have been framed and are applied on the same principles as the author's "Practical Hydraulic Tables and Diagrams," to which they are a self-contained, independent supplement. The tables are of special use in the precise and economic determination of drain and sewer dimensions, the calculation of which is by no means a simple matter, when, as is usually the case, only the required discharge and the available slope in the water surface are known. Numerous working examples are given and the work concludes with a collection of useful hydraulic tables. The simplicity of the formulae used, with their accuracy, will be a strong factor in recommending this book to engineers.

Concrete Bridges, Culverts and Sewers. By A. A. Houghton. Published by the Norman W. Henley Publishing Co., New York. Paper; 5 x 7; 58 pages. Price, 50c.

This is No. 8 of the series of Concrete Worker's Reference books, and illustrates and explains the various types of solid and reinforced arches, slab and girder concrete bridges, with notes on construction; also the moulding of concrete culverts, drains, and sewers, and forms for their construction. This little book, with the preceding one, is intended for the small contractor or builder.

Elementary Principles of Reinforced Concrete Construction. By Ewart S. Andrews. Published by Scott, Greenwood & Sons, London. Size, 4¾ x 7½; 196 pages; 57 illustrations; numerous tables. Price, $1.00.

This volume forms No. 1 of the Broadway series of Engineering Handbooks, and is intended to furnish an inexpensive treatise on reinforced concrete. It is written from an elementary standpoint in an explanatory method, without the use of advanced mathematics, and is at the same time in accordance with modern theory. The theoretical treatment is illustrated by numerous examples which enable the reader to follow the reasoning easily. The notation of the British Concrete Institute is used throughout.

PUBLICATIONS RECEIVED.

Report of the Ohio State Board of Health, 1910. Being the 25th annual report. C. O. Probst, secretary, Columbus, Ohio.

Collection and Disposal of City Waste in Ohio. Being a supplement to the 25th annual report of the State Board of Health of Ohio, and including a report of a study of the collection and disposal of city wastes in Ohio.

Statistics of Railways in the United States. 23rd annual report of the Interstate Commerce Commission, for the year ending June 30th, 1910. Prepared by the Division of Statistics, Washington.

25th Annual Report of the Interstate Commerce Commission. Dated December 20th, 1911.

Department of Public Works, Saskatchewan. The annual report of the Department of Public Works of the Province of Saskatchewan, for the year ending February 28th, 1911.

James Bay Surveys. A report on the James Bay surveys, exploration Cochrane to James Bay, June 9th to Sept. 12th, 1911, by Sydney C. Ells, for the Temiskaming and Northern Ontario Railway Commission.

The Smoke Problem at Boiler Plants. A preliminary report by D. T. Randall, for the Department of the Interior, Bureau of Mines, U.S. A reprint of the United States Geological Survey, Bulletin 334. Revised by S. B. Flagg.

Highway Bridges and Culverts. By Chas H. Hoit and Wm. H. Burr. Bulletin No. 43, of the Office of Public Roads, U.S. Department of Agriculture. Being a revision of Office of Public Roads, Bulletin No. 39.

The Principles of Specification and Agreement Writing. By C. R. Young, being a reprint of a series of articles in The Canadian Engineer. Copies may be obtained from The Canadian Engineer, Toronto. Price 25c.

Signal Installation. Bulletin No. 127, of the General Railway Signal Company, Rochester, N.Y., describing the signal installation on the Chicago and Northwestern Railway terminal, by J. A. Peabody.

CATALOGUES RECEIVED.

Lead Wool. The lead wool method of jointing, a pamphlet by The Lead Wool Company, Ltd., Snodland, Kent.

The Prescot Welder. A pamphlet describing electrical spot and seam welding, issued by the British Insulated and Helsby Cables, Ltd., Prescot, Lancashire.

Sewerage, Water and Sewage Disposal. Pamphlet issued by The Adams Hydraulics, Limited, York and London. Canadian agents, Francis Hankin & Company, 231 Coristine Building, Montreal.

Block System. A pamphlet describing the A. P. Block system for single track steam railroad, by F. L. Dodgson. Issued by the General Railway Signal Company, Rochester, N.Y., being their bulletin No. 128.

Tarvia. A pamphlet illustrating different installations of tarvia pavement, issued by The Barrett Manufacturing Company, New York.

Steam Wagons. Pamphlet describing Foden steam wagons, manufactured by Fodens, Limited, Sandbach, England. Canadian agents, Jones & Glassco, 201 St. Nicholas Building, Montreal.

Products of the Damascus Bronze Company. A very handsome catalogue issued by the Damascus Bronze Co., of Pittsburg, describing the uses of their product.

Hayward Buckets. Catalogue No. 39, of the Hayward Company, New York.

Gasolene Tractors. The International Harvester Co., of Canada, forward catalogue illustrating their Titan kerosene-gasolene tractors.

Steam Turbines. The DeLaval Steam Turbine Co., Trenton, N.J., forward advance copy of Catalogue D, illustrating their multi-stage type of steam turbines.

Metallurgical Comment

T. R. LOUDON, B.A.Sc.

Correspondence and Discussion Invited

THE CARBONIZATION OF COAL.*

Professor V. B. Lewes.

The whole end and aim of carbonization is to obtain as much as possible of the energy stored in coal in the condition most applicable to uses for which it is to be employed, and as these vary over a wide range, practical experience has led to the destructive distillation of coal being carried out mostly under two distinct sets of conditions—the first aiming at obtaining the maximum result from the gaseous products, the second at obtaining the best possible coke, whilst in a third, applied chiefly to shales, it is the liquid products to which most attention is paid. Of late years many attempts have been made to bring the two great industries of gas making and furnace coke production, both dealing with the destructive distillation of much the same class of coal, into line, but in most cases a lack of appreciation of the principles underlying the complex actions taking place during carbonization has proved an obstacle to any important advance, each industry viewing the problem from its own particular standpoint, and failing to grasp the wide differences which exist between substances made as the result of a process designed for their special production and the same bodies when made as a by-product. Furnace coke, as an example, must have certain characteristics to fit it for metallurgical work, which cannot be obtained in the ordinary processes of making good illuminating gas, whilst if the gas is to satisfy the parliamentary requirements laid down for most large town supplies, it is useless to expect to obtain the same volume of it from a coke oven that one would from a gas retort, so that whilst the gas manager hankers after the economies incidental to carbonization in bulk, he is constrained to work with much smaller charges in order to obtain the necessary quality and quantity of gas, and although he uses temperatures quite as high as the coke-oven manager, he misses the factors that are necessary for a good furnace coke.

In regard to the composition of coal, twenty years ago I came to the conclusion that the most satisfactory view to take of the composition of coal was that it consisted of an agglomerate of the solid degradation products of vegetable decay, together with such of the original bodies as had resisted to a greater extent the actions to which it had been subjected, and all the experience of wood, peat and coal carbonization which I have had since confirms me in the opinion that this is in the main correct. The evidence seems to point to the presence in all bituminous forms of coal of degradation products of the original vegetation of a humus or ulmic character, and which is probably the portion carrying the nitrogen.

It has been shown by Muck and other observers that it is not always the coal containing the largest amount of volatile matter that evolves gas most rapidly, or is the richest in hydrocarbons, and this naturally follows from the fact that those coals which have the highest oxygen percentage are mostly those giving high volatile matter, and as these are rich in the humus bodies which yield most of the diluting gas and but little tar or rich hydrocarbon gases, they cannot give the high result of a coal in which the oxygen content is about 10 per cent., or rather lower, and which contains a large percentage of resin bodies. Observers have differed as to the nature of the binding material in coke, some holding that it was the residuum of the semi-fused constituents of coal, whilst others, chief amongst whom was Wedding, consider that it is carbon shed off by the decomposition of heavy hydrocarbon vapors, which is undoubtedly the cause of the carbon hairs found in coking. My own opinion is that the cementing material is due to liquid products, the most volatile of which go off as vapors, leaving pitch, which carbonizes and binds the mass into coke, and in considering the actions taking place during carbonization ample proof of this will be adduced. It is clear that the binding material is formed below 450 deg. C., as if we take a good coking coal and carbonize it at 450 deg. C. we obtain coke which, although not strong, is perfectly luted together; but if we now powder this low-temperature coke and again carbonize it, a large yield of poor gas is evolved, but no coking of the residue takes place. There is no doubt in my mind that it is the resin bodies and their derivatives, the hydrocarbons in the coal, that form the tar, which yields the pitch which lutes the coke, and also that the resin bodies play a very important, if not the chief, part in the weathering of coal.

Experience shows that the weathering of coal is a phenomenon which is dependent upon the absorption of oxygen from the air, and this weathering is fatal to the coking of some coals, the slacks of which are so susceptible to oxidation that a few days' or weeks' exposure destroys their coking power. Now, the avidity of oxygen for some vegetable resins is well known, the rapidity with which copal will absorb oxygen from the air may be taken as an example; common resin has itself been formed by the oxidation of turpentine, and countless ages under conditions tending to reduction may well have whetted anew the resinic appetite for oxygen. In any case the resin bodies are the compounds present in the coal most likely to possess this property, and it is the chemical actions so caused which lead to slow combustion and, when accelerated by any rise in the surrounding temperature, is capable of generating sufficient heat to lead to the spontaneous ignition of masses of broken coal large enough to prevent the escape of the heat as it is developed. Coal exhibits to a lesser extent the same property of absorbing gases that charcoal does, and the least absorbent will take up one and a quarter times its own volume of oxygen, whilst many bituminous coals will absorb more than three times their volume of gas. This action, at first largely physical, presents the oxygen in a probably active condition to the resin bodies in the coal, and leads to the rapid "weathering" and destruction of the coking properties found in some kinds of coal.

The lines of research intended to throw light on the composition of coal have been either to distil the coal at various temperatures and to draw inferences from the products of the nature of the original substance, or, to directly attack the coal by means of solvents. The early attempts to isolate definite bodies from coal by solvents were none of them very successful, but Bedson made a great advance in this line of research when in 1899 he pointed out the solvent power of pyridine bases, extracted from coal tar, which dissolved 16 to 18 per cent. of a Durham coal, but had no action on anthracite. In 1901 Baker experimented upon the action of this solvent on several coals, and found that from Durham coal (Hutton seam) 20.4 per cent. could be extracted with pyridine, and that after extraction the residue had lost the coking properties of the original coal.

* Abstract of a paper read before the Royal Society of Arts.

This observation was confirmed by Anderson and Henderson in 1902, who tried the action of pyridine in a research upon the coals of Bengal and Japan, and also upon some Scotch coals, the coking powers of which were known. They found that the extraction of a strongly coking coal by pyridine weakened the coke, whilst with inferior coking coal the property is entirely destroyed. In 1908 Professor Bedson read a paper before the society of Chemical Industry, in which he gave the results of experiments upon six coals obtained from the Redhaugh gasworks, which seem to show that with some gas coals an amount equal to practically the whole of the volatile matter capable of being driven off by heat can be extracted by pyridine.

	Volatile matter. Per cent.	Pyridine extract. Per cent.	Gasworks yield. Per ton.	Candle power.
I.	34.10	32.36	11,381	16.63
II.	33.28	33.39	11,392	16.30
III.	31.91	24.58	11,646	16.40
IV.	31.7	22.81	11,108	16.00
V.	33.66	29.77	10,913	16.39
VI.	30.87	22.63	10,730	16.76

Now, from these figures the inference is that in a coal like II., everything beside the fixed carbon and ash has been dissolved—that is, humus, resin and hydrocarbon bodies—and it would have been of the greatest interest had Professor Bedson made an analysis of the residue, or at any rate had shown that no volatile matter was left in it.

It appears probable that in a feebly coking coal the coking property is due almost entirely to the soluble form of resin constituent, and can therefore be entirely removed by extracting the coal with pyridine; whilst on the other nand, in strongly coking coals the property is due partly to soluble resin bodies, but to an even greater extent to other hydrocarbons of resinic origin, which resist the solvent action of the pyridine, so that the coking property is weakened but not destroyed by extraction. A similar conclusion was arrived at by Anderson and Roberts in 1898, from an entirely different point of view. Dr. Percy, more than fifty years ago pointed out the fatal effect of weathering upon certain coals and slacks, and showed that if a fairly good coking coal was kept at a temperature of 300 deg. C. for a few hours, and is afterwards heated to redness, it does not swell and coke. Anderson and Roberts, in trying this with various Scotch coals, found that, although it was true for a coking coal of medium power, a really strongly coking coal had the power only weakened, and they found also that the same phenomenon could be brought about by treating the two coals with sodium hydrate. The conclusion is that although resinous bodies which can be saponified or oxidized contribute largely to the coking, yet there are also present non-saponifiable bodies which in breaking up under the influence of heat, yield enough luting to form coke. I think the action of pyridine shows that these non-saponifiable bodies consist of substances very probably akin to those found in shale and some cannels. Burgess and Wheeler, in a paper read before the Chemical Society this year, took a Silkstone coal containing 33.4 per cent. of volatile matter, and succeeded in extracting 30 per cent. by means of pyridine, leaving a cokelike residue, which on distillation at 900 deg. C. yielded hydrogen and oxides of carbon—they would have found methane as well if they had looked for it—whilst the extract on destructive distillation yielded a mixture of the paraffin hydrocarbons and hydrogen. At first sight this looks as if pyridine was a solvent which could be used to separate the humus and resin constituents, but Messrs. Burgess and Wheeler are careful to point out that they hesitate to identify absolutely the paraffin-yielding constituents of coal with that portion extracted by pyridine, and they are wise in being cautious, as there are several anomalies to be cleared up. I have found several times that after extraction the residue contains as much volatile matter as the original coal, and sometimes more, in spite of repeated washings with acid, drying in vacuo and other forms of treatment intended to eliminate all pyridine, whilst the composition of the extract also shows anamalous results, and after the most careful measures have been taken to free it from pyridine, it will sometimes still contain more nitrogen than did the original coal.

Coal always contains a certain proportion of water which appears to be partly mechanically held and partly in some form of combination. In this it resembles wood, which after long air-drying still retains an average of 20 per cent. of moisture, which, if got rid of at an elevated temperature is reabsorbed from the air. The mechanically-held portion in coal is generally known as "pit-water," and represents ordinary wetting, which can be got rid of by air-drying, but the so-called "hygroscopic water" is driven out only by drying at 103 deg. C., and as this heating for some hours causes oxidation of the resin bodies, it also tends to destroy the coking properties of the sample. This result has led some observers to conclude that hygroscopic water is essential to coking, which is manifestly incorrect, as the tertiary coals, which contain the largest quantity of hygroscopic moisture, will not coke owing to the proportion of humus derivatives being largely in excess of the resin bodies.

Many classifications of coal have been suggested, some based on their chemical, some on their physical, and others on their coking properties, and of the latter the most generally adopted is that suggested by Gruner, in which he tabulates bituminous coals into five classes; although Schondorff, Muck and others have shown that it is not applicable to all kinds of coal, still this criticism applies to all classifications that have been proposed.

		Carbon. Per cent.	Hydrogen. Per cent.	Oxygen. Per cent.
1. Dry Coal	Long flame and non-coking	75—80	4.5—5.5	15.0—18.5
2. Fat gas coal	Coke porous and brittle	80—85	5.0—5.8	10.0—13.2
3. Semi-fat or furnace coal	Good coke but porous	84—89	5.0—5.5	5.5—10.0
4. Coking coal	Best coke	89—91	4.5—5.5	4.5— 5.5
5. Lean Coals and anthracite	Non-coking	90—93	3.0—4.5	3.0— 4.5

This arrangement shows not only the coking properties, but also the changes in composition which the coal undergoes—the concentration of carbon and reduction in highly oxidized bodies. In the first class we have the dry coals, yielding large volumes of gas and liquid products on distillation, and these coals—as might be expected—most resemble the lignites, and share with them the property of non-coking or binding together of the residue on carbonization. This is due to the fact that the humus-like bodies are still present in much larger quantities than the resinic compounds and hydrocarbons, and as on disillation they leave no binding material in the residue the resinic bodies cannot supply enough to give more than a friable mass. In the second class of coals altered conditions of temperature, pressure and time have led to further decompositions of the humus bodies, and the resinic constituents and hydrocarbons having increased in ratio by concentration, a point is reached at which coking takes place, although not of a satisfactory character. In the third class the action still has continued with further concentration of the resin bodies, hydrocarbons and residuum, with the result that the former bodies are so increased in comparison to the humus and residuum that a good coke results. In the fourth class the proportion of resin and hydrocarbon bodies has reached the right ratio as compared with the humus and residuum, and the best coking coal is obtained. Bituminous coals of the kind classified by Gruner may, therefore, be looked upon as an agglomerate of humus and the degredation products of these bodies down to carbon, luted and protected by resin

bodies and their derivatives; steam coal and anthracite as the degradation products of humus which has nearly completed its decomposition owing to the small quantity of resin bodies in the original vegetation; and cannel coal as consisting mainly of resin bodies, which having been in a semi-fluid condition, have mingled with the earthly matter in contact with it, so obtaining the high ash found in many kinds. In putting forward this theory as to the composition of coal, I wish it distinctly understood that by the terms "humus" or "resin" bodies, I do not imply any one definite compound, but merely bodies of this character, the humus bodies all containing a percentage of hydrogen from 5 per cent. downwards, whilst the resin bodies all contain a percentage of hydrogen above 5 per cent. If it is once admitted that coal is a conglomerate of the kind I have indicated, it explains all those obscure points which no other theory touches—such as why with two coals of almost identical composition and of high oxygen content, one should be a coking and the other a non-coking coal; the reason being that in the one the high oxygen content is due to humus bodies, which will not coke owing to the low pitch-forming nature of the hydrocarbons, whilst with the other the oxygen is due to resin bodies, which are essential to good coking.

All the evidence that can be adduced shown that when a coal undergoes destructive distillation all the hydrocarbons, together with the resin and humus constituents, undergo decomposition at a temperature certainly well below 700 deg. C., and that as the liquid and gaseous products distil out they leave behind their less volatile residues as a pitch, which lutes together the carbon particles and forms soft coke, whilst as the temperature rises above 750 deg. C., he pitch residue decomposes, yielding hydrogen, carbon monoxide and methane as gases. The carbon residue from the pitch binds the residual mass into coke, and it is this residual pitch that Burgess and Wheeler have mistaken for a primary constituent of coal. It is clear, however, that (putting detail on one side until our knowledge has been broadened by experience) the answer to the question as to what is the composition of coal—whether the answer is derived from a consideration of the actions taking place during its formation and of the substances from which it was derived, or is obtained from analytical data, as was done by Anderson and Roberts, or from the products of distillation as has been attempted by Burgess and Wheeler—must be that coal is a conglomerate of humus and its degradation products with the resinic bodies and their derivatives.

THE EFFECT OF VARIOUS SUBSTANCES ON THE RATE OF CORROSION OF IRON BY SULPHURIC ACID.*

By Oliver P. Watts.

In Vol. 8 of the transactions of this society, C. F. Burgess called attention to the remarkable reduction in the corrosion of iron by sulphuric acid, brought about by the addition of a small amount of arsenious oxide to the acid. Later he explained the protective action as follows: "The explanation which has been offered for this phenomenon is that the iron receives, by contact with the solution, an extremely thin coat of arsenic which resists the action of the acid and protects the underlying metals." He also gave experimental proof that the iron was coated with arsenic.

It has long been known that by dipping clean iron into solutions of suitable composition and concentration thin coatings of gold, silver, platinum, copper, and several other metals may be deposited on the iron. It is generally conceded that such coatings are not sufficiently continuous and impervious to protect the underlying metal from corrosion, even though the metal forming the coating may itself be thoroughly resistant to the corrosive agent. Instead of being a protection, such coatings are usually considered to be stimulators of corrosion.

Since all metals which thus deposit upon iron when it is immersed in a solution of the metallic salt are electro-negative to iron, a short-circuited voltaic cell is formed. of which the iron is anode and the metal deposit is the cathode. So long as any iron remains in contact with the electrolyte, it would seem, except for certain considerations which will be presented later, that the corrosion of the iron ought to be stimulated by this condition, and that the only way in which such a coating could afford good protection would be by covering the iron completely, so that no electrolyte could come in contact with it.

Speaking of the effect of other metals in contact with iron, W. H. Walker says: "Tin is a metal which, like copper, accelerates the corrosion of iron by aiding in the oxidation of the hydrogen set free by the reaction." M. P. Wood calls attention to the injurious action of metals, "The use of anti-corrosive, or anti-fouling paints, containing salts of any metal, is attended with the greatest danger to the coated (iron or steel) structure. These pigments are extremely sensitive to the presence of saline elements in moisture, their action being to rapidly dissolve portions of the iron, and to deposit the metal which they contain upon the surface of the plates, and these deposits, exciting energetic galvanic action, cause corrosion and pitting to go on with alarming rapidity. Both mercury and copper salts are offenders in this way."

It appears then, that arsenic is unique among the metals which precipitate themselves upon iron from solution, for arsenic protects iron almost completely from powerful corrosive agents, while the other metals are generally considered to aggravate corrosion and rusting. The protective action of arsenic cannot be due to any superior power of resisting attack by sulphuric acid, for silver, platinum and gold are even more resistant, and yet accelerate the corrosion of iron. It is evident that these other metals do not form continuous and impervious coatings over the iron, else they would protect it. It is difficult, perhaps even impossible, even with the aid of the electric current, to deposit from solution a thin coating of one metal upon another, so perfectly as to protect the underlying metal from corrosion by an acid ordinarily capable of attacking it. It is almost incredible that a thin yet perfect and non-porous metallic coating should be deposited by a process which depends for its operation upon the dissolving of the underlying metal. The protective action of coatings of copper, silver, etc., thus deposited on iron is about as effective as would be expected from a knowledge of their method of formation. They are continually being undermined by the corroding of the iron anode at points not yet covered, until the copper or silver becomes detached, to have its place taken by a new coating, and so on, as long as any of the salt of the depositing metal remains in the solution. If the coated metal be removed to an acid, the corrosive action is similar, except that the renewal of the coating can take place only at a rate not greater than that at which the detached metal redissolves in the acid.

If the coating of arsenic is so porous and imperfect as the action of acids shows the coating of copper, for example, to be, how can the arsenic protect the iron any better than copper does? It occurred to the writer that the ex-

* Abstracted from a paper read before the Am. Electro-Chem. Soc., April 20th, 1912.

planation lay in a high overvoltage or excess potential of hydrogen on arsenic, and the experiments which follow were undertaken to discover whether this is the explanation of the singular and mysterious protective action of arsenic. If the above explanation is correct, among the metals which deposit upon iron when it is immersed in a solution of their salts those having overvoltage for hydrogen should protect iron, and those of very low overvoltage should aggregate corrosion.

If an electrode of platinum coated with platinum-black be immersed in normal sulphuric acid the electrode will be electro-negative to the solution by about 1.14 volts. If now a small but slowly increasing electromotive force be applied between this electrode and an insoluble anode it will be found that the platinized cathode becomes progressively electronegative with regard to the solution. When a certain difference of potential between the cathode and the solution is reached, bubbles of hydrogen begin to appear on the cathode. If a cathode of smooth platinum is used, hydrogen will not appear on this until it has become 0.09 volts more positive than the other cathode was when hydrogen first appeared on it. Similarily zinc must be 0.70 and mercury 0.78 volts more positive than the platinum-black before hydrogen appears upon them. This excess of potential required to cause a visible liberation of hydrogen upon a cathode of any particular metal, over the potential required for the liberation of hydrogen upon platinum coated with platinum-black, is known as the overvoltage of hydrogen upon that metal. In Table I. are given the single potentials in normal solutions of the sulphates of the metals, and the overvoltage of hydrogen as stated by different observers.

Table I.

		Overvoltage in normal sulphutic acid			in 5 per cent. KOH,
	Single Potential	Caspari[4]	Foerster[5]	Harkins[6]	Nutton and Law[7]
Mercury	—0.98	0.78	0.43	0.74	
Zinc	+0.524	0.70		0.71	0.70
Lead	—0.095	0.64	0.35	0.62	0.57
Tin	—0.085	0.53	0.43	0.55	0.61
Cadmium	+0.162	0.48	0.48		0.52
Arsenic	—0.550			0.39	
Bismuth	—0.490			0.38	
Iron	+0.093				0.15
Copper	—0.515	0.23	0.10	0.25	0.41
Cobalt	—0.019			0.22	
Nickel	—0.022	0.21	0.10	0.15	0.37
Silver	—0.947	0.15		0.13	
Platinum	—1.140	0.09	0.07	0.07	
Gold	—1.356	0.02	0.055		

On the theory that the protection of iron by a deposit of arsenic is due to the high overvoltage of hydrogen on the latter the action would be as follows: Iron dissolves and by so doing deposits arsenic upon the surface of the iron. Since the arsenic is deposited simultaneously with the dissolving of the iron, and only as a result of this dissolving, it is hardly possible that the iron should be perfectly covered by arsenic, but here and there holes will exist, allowing the iron to make contact with the electrolyte. Voltaic cells are thus formed. From the single potentials of iron and of arsenic, + 0.093 and —0.550, these cells should have an electromotive force of 0.64 volts, and the corrosion of the iron ought to be very vigorous. It is here that the overvoltage of hydrogen comes in play. The iron is anode and the arsenic cathode, and, just as in any other primary cell with sulphuric acid as electrolyte, hydrogen is deposited on the cathode. But when hydrogen is liberated on arsenic the potential of the latter is raised 0.39 volts higher than —0.277, the potential at which hydrogen is liberated on platinum-black. This would rise the potential of the arsenic to + 0.113 volts, or higher than the potential of the iron anode. This means that in our iron-arsenic cell there can be no visible evolution of hydrogen on the arsenic, for before this can occur the potential of the cathode has become equal to that of the anode, and corrosion of the iron ceases, in other words, this particular primary cell polarizes so badly that after a few seconds of action its electromotive force has fallen to zero.

If the above explanation is correct, protection should be afforded by those metals which plate out on iron by immersion, and whose overvoltage for hydrogen is great enough to raise their potentials to at least equal the single potential of iron. The potentials of the following metals are far enough below that of iron to expect that they will deposit on iron even in moderately strong sulphuric acid: antimony, arsenic, bismuth, gold, lead, mercury, platinum, silver and tin. Potential measurements made by students in the writer's laboratory indicate that chromium should be included in the list. Omitting lead, on account of the insolubility of its sulphate, mercury, tin, and arsenic show the highest overvoltage; compounds of these metals were therefore used in a preliminary experiment, by A. C. Shape.

From the experiments certain definite conclusions can be drawn and other generalizations now appear profitable, but may require revision or rejection in the light of future experiments.

The writer's hypothesis, that the protective action of arsenic is due to its high overvoltage, has been in a general way confirmed. Other metals of high overvoltage have had a protective influence, while all metals of low overvoltage which deposits on iron are accelerators of its corrosion. So far as overvoltages are known, bismuth alone fails to conform to the hypothesis. Theoretically it should retard corrosion; actually it is an accelerator. Unless redeterminations of the overvoltage of bismuth and the single potential of iron shall reconcile theory with fact, the writer's hypothesis fails. The overvoltage of bismuth was presumably measured on a solid electrode. Bismuth deposited as a powder. If there is the same difference in overvoltage for bismuth as between smooth and spongy platinum, this correction would put bismuth in the list of accelerators.

The statements which follow are intended to apply only to the corrosion of iron by sulphuric acid.

Tin, chromium and mercury retard corrosion; of these, tin alone is as effective as arsenic. The protective action of mercury is very slight.

In studying the effect of different reagents on corrosion it is necessary to consider both the metal and the non-metal or acid radical, since each may have an effect of its own.

The binary salts and acids of the halogens are very good protective agents when used in considerable amounts. To combine most effectively the protective effects of a metal and a halogen, e.g., tin and chlorine, much stannous chloride should not be added, for a large amount of the salt of any metal which precipitates on iron in an acid solution is likely to act as a corrosive agent; only a small amount of stannous chloride should be added, and the extra chloride added as sodium chloride.

Oxidizing agents are in themselves accelerators of corrosion by acids, although in dilute solution this may be masked by a protective action which supervenes when the oxygen has been used up, as might happen with chromates.

Reducing agents should show more or less protective action, but this fact remains to be confirmed by further experiment.

In general, the whole subject as here presented is but a preliminary study which opens many possibilities for future investigation. It is hoped that the data appended

may prove of service to those wishing to pursue the subject, and that the writer's conclusions may meet with confirmation from independent sources.

For convenience in comparing the effects of different reagents, an index is appended.

Retarders of Corrosion.—Acid, hydrobromic; acid, hydrochloric; acid, hydrofluoric; arsenate of sodium; arsenic sulphate; bromide of potassium; chloride of ammonium; chloride of manganese; chloride of mercury; chloride of sodium; chloride of tin; chrome alum; chromium sulphate; fluoride of potassium; hydroquinone; iodide of potassium; mercury chloride; mercury sulphate; resorcine; stannate of sodium.

Accelerators of Corrosion.—Acid, chromic; bismuth sulphate; chromium chloride; copper sulphate; gold chloride; mercurous nitrate; platinum chloride; potassium chlorate; potassium chromate; potassium dichromate; potassium nitrate; potassium permanganate; silver nitrate; silver sulphate.

Of no Effect or Doubtful.—Ammonium sulphate, antimony, sulphate, boric acid, citric acid, potassium sulphate.

THE PRESERVATION OF POWER TRANSMISSION POLES.*

By W. R. Wheaton.

The following account deals with an experiment which is complete and covers a long period:—

In March, 1908, the San Joaquin Light & Power Corporation set a line of Western yellow pine (pinus ponderosa) poles. The line is about thirty miles long and contains approximately 600 poles. These poles were cut in the Sierras above Fresno at an elevation of about 4,000 ft., and thoroughly seasoned before treatment. A portion of the poles were given a brush treatment with carbolineum and with creosote, and the balance were treated in the open tank with creosote, zinc chloride and crude oil. The butt only was treated. Western yellow pine is very susceptible to a preservative treatment. Some of the butts were thoroughly penetrated with creosote and with zinc chloride, the average penetration at the ground line being 3 in. The penetration with crude oil averaged about 1½ in. The crude oil used was a heavy oil of asphaltum base supplied from the Kern River fields. In order to get a comparative life of the wood treated and untreated, stubs of untreated timber were set along the line about a mile apart. The writer inspected this line in June, 1910, at which time it had been set for 27 months. The untreated stubs set along the line were completely rotten. Of the poles given a brush treatment with creosote, 27 per cent. showed signs of decay and 29 per cent. of the poles given brush treatment with carbolineum. Of the poles treated with crude oil 45 per cent. were slightly attacked, and of the poles treated with zinc chloride, 28 per cent. showed attack. The poles treated with creosote in the open tank (over 50 per cent. of the entire line was treated in this way) were all perfectly sound and showed no signs of decay.

In August, 1911, two of the poles in this line which had received a brush coating of creosote fell over, due to the decay of the butt. During August and September, 1911, the line was gone over and all of the poles which had been given a brush treatment of creosote and carbolineum were so badly decayed that they were strapped to a creosoted cedar stub.

Since the erection of the plant by the San Joaquin Light & Power Corporation Western red cedar has been treated. The butts only are treated by the open tank process. There is no necessity for treating the top, since the top is not subject to decay. With this process it is attempted only to fill the outer ring of sapwood with creosote, and if the timber is thoroughly seasoned there is little difficulty in accomplishing this. The penetration varies with the width of the sapwood from ½ in. to 1 in. with an absorption of from 7 to 9 lb. to the cubic foot. There are treated and untreated cedar poles in the lines which have been set for four years. The creosoted poles are still perfectly sound, while the poles set untreated have decayed through the sapwood and into the heart.

Creosote is used in preference to chloride of zinc or other treatment which might be effective in an arid climate because after the installation of the irrigation systems the poles are often in the middle of irrigated fields, where zinc is washed out of them, so that they have to be replaced after a brief service. A 50-ft. creosoted pole placed in the line means an investment of about $25, while the use of chloride of zinc would cut this cost to about $24.25. The saving is too small to be considered against the possibility of the loss of the preservative in one or two years.

* Abstract of paper presented at Annual Convention of Wood Preserver's Association, Chicago.

LIGNO-CONCRETE.*

By Gerald O. Case (Member).

In the introductory remarks, the author refers to the use in America and Australia of concrete in combination with timber, and points out that, while the concrete effectively preserves the timber, it is not used to the greatest advantage. The object of the author's investigations was to ascertain if it were possible to reinforce concrete with timber rods. Roughly speaking, steel is about eight or nine times stronger than timber, but ten to fifteen times as expensive. The efficiency of timber, as a reinforcing material, depends on whether there is sufficient adhesion between the timber and the concrete, and whether the difficulties of the absorption of moisture by the timber from the wet concrete, and the splitting the latter, can be overcome.

The paper describes the experiments made by the author to ascertain (a) the amount of water absorbed by eighteen kinds of timber immersed in fresh water, along the grain and through the end grain respectively; (b) the relative absorption by the timber of fresh and sea water in the same period; (c) the relative amount of water absorbed by timber embedded in 6 to 1 concrete and neat cement blocks; (d) the effect of applying wood preservative, creosote, varnish, etc., to the timber before insertion in the concrete or cement blocks; (e) the effect on the adhesion between the timber and the concrete of soaking the rods before insertion. Examples are given to show that concrete effectively preserves timber embedded in it.

Particulars are given of the construction of twenty-five concrete beams reinforeed by timber rods. Three lignoconcrete beams, 8 in. deep by 4 in. wide, were tested with a central load on a 4 ft. span, the average ultimate load producing fracture about three tons. The results of these tests are compared with the tests on ferro-concrete beams recorded by Mr. E. Marburg in the Proceedings of the American Society for Testing Materials (1904, Vol. IV.). It appears that for the same ultimate strength of beam it is necessary to use 9 per cent. of sectional area of pitch pine

* Abstract of paper read before the Society of Engineers, London. April 1st, 1912.

tensile reinforcemnts as against 1 per cent. steel reinforcements. A comparison of the prices of steel and pitch pine shows a saving in favor of ligno-concrete.

As the author points out, in cases where more than about 1.2 per cent. of steel reinforcement is required, ligno-concrete cannot compete with ferro-concrete, because the required size of the timber bars would be too large for convenient use. There appears, however, to be a big field for it for use in constructing bungalows, buildings for small holdings, floors, piles, posts, fencing, coast and river works, etc. It has already been used for making fence posts and for building a short length of sea wall. The ligno-concrete fence-posts cost about two shillings per cube foot. They are about 20 per cent. cheaper than creosoted deal, and about 40 per cent. cheaper than Engish oak. In Canada four bungalows have been built with ligno-concrete slabs, and the Pacific Coast Construction Company, of Victoria, British Columbia, now have contracts in hand for twenty buildings in which this material is to be used.

ENGINEERING NOTES.

Regina, Sask.—There is a probability that the position of city engineer will be vacant owing to the present incumbent, Mr. Thornton, being appointed works commissioner.

Lethbridge, Alta.—The fire rangers of the Rocky Mountain reserve will meet in this city and consider the question of installing a telephone line throughout the forest. Mr. S. J. Gilling, telephone expert for the provincial government, has prepared a report on the subject.

PERSONAL.

Mr. James C. Lindsay has been re-appointed engineer for the municipality of Belleville, Ont.

Mr. W. H. Sullivan has been appointed to the position of chief engineer of the Welland Ship Canal.

Announcement is made of the appointment of **Mr. J. L. Weller** to the position of charge of the Welland Ship Canal.

Mr. J. C. Gardner has been appointed engineer-superintendent on the construction of the good roads of Welland County, Ontario.

Mr. I. F. Willsie has taken charge of reconstruction work on the Canadian Pacific Railway. Until recently Mr. Willsie has been assistant engineer for the city of London, Ont.

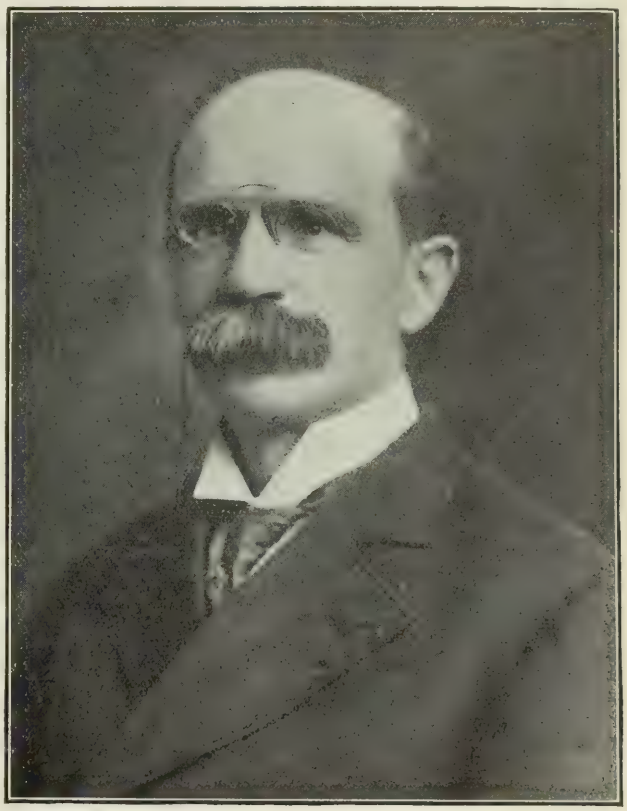
Mr. H. H. Adams has been appointed to the position of president of the Kansas City terminals. Mr. Adams was formerly manager of the Toronto, Hamilton and Buffalo Railway.

Mr. R. W. Heafield, 264 Reid Street, Peterboro', Ont., was the author of an article on "The Material List Method of Store-Keeping," which was published in The Canadian Engineer of April 11, 1912. Mr. Heafield will be glad to furnish further details of the method to any one sufficiently interested to enquire.

Mr. Gunni Jeppesen, who was for many years designing engineer of The Strauss Bascule Bridge Co., of Chicago, Ill., has been appointed managing engineer of the same company. Mr. J. R. Hall, who was formerly chief draftsman, has been appointed designing engineer, and is succeeded as chief draftsman by Mr. A. O. Walker.

Mr. W. W. VanEvery has just been appointed city engineer of Sault Ste Marie, Ont. Mr. VanEvery graduated from the School of Practical Science, Toronto, thirteen years ago, and since then has been continuously engaged in different kinds of engineering work, both in Canada and in the United States. While in the United States he was construction engineer with the Lackawanna Steel Company during the construction of their new plants at Buffalo, N.Y., and Lebanon, Pa. Later he was sales engineer for the Allis-Chalmers Company, of Milwaukee, Wis. In Canada he has been connected with the construction of the following new plants: The Canada Car & Foundry Co., at Turcot, Montreal; M. Beatty & Sons, Welland, Ont.; The Tallman Brass & Metal Co., Hamilton, Ont.; extension to the Canada Screw Company's plant at Hamilton, and extensions to the Harris Abattoir plant, Toronto. He has also done considerable consulting work besides, and previous to taking the city engineership of the Soo, was engineer for the Algoma Steel Company of the same city. Mr. VanEvery is an associate member of the Canadian Society of Civil Engineers.

Mr. C. H. Rust, M. Can. Soc. C.E., M. Am. Soc. C.E., has tendered his resignation as city engineer for Toronto. Mr. Rust was born in Essex, England, December 25th, 1852; was educated at Brentworth Grammar School, and began professional work under the late Mr. Frank Shanley. In



the year 1877 he entered the employ of the city of Toronto as rodman; in 1881 he was appointed assistant municipal engineer, and during the year 1892 took charge of the city's work, but it was not until February, 1898, that Mr. Rust was appointed city engineer. Mr. Rust was elected a member of the Canadian Society of Civil Engineers in 1887, and in the year 1901 was honored by the position of vice-president of that body. In 1911 he was elected president of this organization. He was interested in other engineering and municipal societies, having been elected a member of American Society of Civil Engineers, the American Society of Municipal Improvements, and the American Waterworks Association.

OBITUARY.

Through the "Titantic" disaster Canadians lost a prominent metallurgical and chemical engineer in the person of **Mr. Ernest Sjostedt.** He had been connected with the erection of many important steel and metal plants, among which are the reduction plant and the water gas plant at Sault Ste. Marie, and the Standard Chemical works. He was a native of Sweden and a graduate of the School of Mines, Stockholm. When he met his death he was returning from a business trip in the interests of The Lake Superior Corporation and the Dominion Government. He was sixty years of age.

The engineering fraternity recently lost one of its members in the person of **Charles Beresford Fox,** of the firm of Fox and Wragge, Toronto. He was the eldest son of Mr. Francis Fox, a member of the firm of Sir Douglas Fox and Partners, civil engineers, London, England. Mr. Fox has been a resident of Toronto for the past three years. Prior to coming to Toronto he had been engaged in many important engineering works, having passed some years in South Africa on the Rhodesian railways, and at the construction of the bridge over the Zambesi River at Victoria Falls. He was also engaged for about two years at the building of the Assiout Barage on the Nile in Egypt, and for a time at the Simplon Tunnel. His death occurred on April 15th last.

COMING MEETINGS.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester St. W., Montreal. Meeting of the Mechanical Section. Thursday, April 25th, at 8-15 p.m. Paper on "Distribution of Stress in Certain Tension Members," by Mr. C. Batho, A.M. Can. Soc. C.E.; Secretary C. H. McLeod

CANADIAN INSTITUTE.—198 College Street, Toronto. Saturday Evening Lectures, 8 p.m. April. 27th—"Early Economic History of Canada," S. A. Cudmore, Toronto University. Nominations. May 4th—Annual Meeting and Election of Officers.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary. Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta.; Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. V. Ross.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment. London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
4-30	Tunnel sewer, Edmonton, Alta. .....(S.)	4-4
4-30	Trunk sewer, Edmonton, Alta. .....(S.)	4-11
4-30	Subway, Moose Jaw, Sask. .....(P. & S.)	4-18
5-10	One diesel oil engine, Vernon, B.C. .....(S.)	4-25

(Saskatoon plans and specifications are on file at The Canadian Engineer Office, 820 Union Bank Building, Winnipeg).

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Arborg, Man., school house	May 1.	Apr. 11.	59
Bay View, N.S., lifeboat house and dwelling	Apr. 30.	Apr. 11.	60
Calgary, Alta., timber structures	May 15.	Apr. 18.	76
Calgary, Alta., concrete structures	May 1.	Mar. 28.	70
Calgary, Alta., designs for aqueduct	May 1.	Feb. 22.	70
Edmonton, Alta., tunnel sewer	Apr. 30.	Apr. 4.	72
Edmonton, Alta., trunk sewer	Apr. 30.	Apr. 11.	72
Fort William, Ont., garbage incinerator	May 15.	Apr. 18.	74
Fredericton, N.B., school building, St. Mary's Reserve	May 2.	Apr. 18.	60
High River, Alta., laying water mains, etc.	Apr. 30.	Apr. 18.	59
Kerrisdale, B.C., outfall sewer, etc.	Apr. 29.	Apr. 18.	59
Little Pines, Sask., school house, etc.	May. 6.	Apr. 4.	60
Macdonald, Man., grading	Apr. 24.	Apr. 11.	59
Moose Jaw, Sask., subway	Apr. 30.	Apr. 18.	74
Moose Jaw, Sask., public library building	Apr. 24.	Apr. 18.	59
Muncey, Ont., alterations to Industrial School	May. 1.	Apr. 4.	60
Ottawa, Ont., steel tug	Apr. 22.	Apr. 11.	60
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., fishing protection vessel	June 17.	Apr. 18.	74
Ottawa, Ont., improvements to Lock 15	Apr. 26.	Apr. 11.	60
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Prince Albert, B.C., sidewalks	Apr. 30.	Apr. 18.	60
Regina, Sask., electric supplies, Sec. 6 to 9	May 15.	Apr. 11.	72
Saskatoon, Sask., superstructure 23rd Street subway	May 17.	Apr. 18.	76
Sault Ste. Marie, Ont., widening lower entrance channelway	May 10.	Apr. 18.	60
Selkirk, Man., bridge, Gunn's Creek	May 7.	Apr. 18.	60
Vancouver, B.C., pumping engine, hose wagon, etc.	May 2.	Apr. 11.	60
Winnipeg, Man., twelve additional rooms to Britannia School.	Apr. 30.	Apr. 18.	60

TENDERS.

Berlin, Ont.—Tenders will be received by the town of Southampton until May 1st, 1912, for the laying of 500 ft. of 15-in. sewer pipe along the lake shore road. Full particulars may be had on application to Messrs. Bowman & Connor, Civil Engineers, Berlin, Ont.

Berlin, Ont.—Tenders will be received up to April 27th, 1912, for the construction of a new bridge over the River Nith, one mile north of New Hamburg, bridge consisting of (a) 110-ft. steel span; (b) concrete abutments. Specifications, etc., at the office of Messrs. Bowman & Connor, Civil Engineers, Berlin, Ont.

Brantford, Ont.—Tenders will be received by Geo. W. Alderson, Secretary-Treasurer, S. S. No. 3, Grandview P.O., until April 30th, 1912, for the erection and completion of an eight-room school house at Grandview. Plans and specifications at the office of the architects, Messrs. Taylor & Taylor, Hope Chambers, Brantford, Ont.

Denfield, Ont.—Tenders will be received by E. R. Barclay, clerk of Lobo Township, Poplar Hill, until Wednesday, May 1st, 1912, for concrete abutments and steel superstructure for a bridge over the Sydenham River at Ivan P.O., Lobo Township. Also for three small concrete bridges. Plans, etc., may be obtained either from F. W. Farncomb, consulting engineer, London, Ont., or James McNair, commissioner, Denfield.

Exeter, Ont.—Tenders will be received up to Monday, May 6th, 1912, for about 6,000 feet of 4" and 6" cast iron waterworks pipe, also about one dozen hydrants and valves. F. W. Farncomb, consulting engineer, London, Ont. (See advt. in Canadian Engineer.)

Exeter, Ont.—Tenders for the construction of about 3,000 feet of vitrified sewer pipe will be received up to noon of May 10th, 1912. Plans and specifications at office of F. W. Farncomb, consulting engineer, London, Ont., and T. B. Carling, town clerk, Exeter, Ont. (See advt. in Canadian Engineer.)

Guelph, Ont.—Tenders will be received until May 3rd, 1912, for the laying of 3,000 feet of track on the York Road, in the city of Guelph. Plans and specifications at the office of the City Engineer or the Guelph Radial Railway Company. (See Advt. in Canadian Engineer.)

Lebret, Sask.—Tenders for the erection of a brick veneer school building will be received up to May 31st, 1912. Plans and specifications may be seen at the office of W. Crossley, Lebret, Sask, or at secretary-treasurer, J. Z. Lafleur's office, Lebret, Sask.

Moose Jaw, Sask.—Tenders will be received by the City Commissioners until May 15th, 1912, for the laying of approximately 34,000 square yards of pavement. Plans, etc., at the office of J. Antonisen, City Engineer. (See Advt. in Canadian Engineer.)

Moose Jaw, Sask.—Tenders will be received by the City Commissioners, Moose Jaw, up to May 1st, 1912, for the laying of approximately 4-5 mile of sewer and water mains. Plans and specifications may be obtained from J. Antonisen, city engineer.

Montreal, P.Q.—The management of the Cedar Rapids Power Co. are inviting tenders for the construction of a dyke and a portion of the power house. This work will cost about $2,000,000.

Montreal, P.Q.—Mr. L. N. Seneca, secretary Board of Commissioners, will receive tenders up to noon, April 30th, for the construction of retaining walls around the ponds in Lafontaine Park.

Orangeville, Ont.—Dr. Riddell, mayor of this municipality, will receive tenders for reinforced concrete bridge to be erected on the West Roadway. The tenders are to be in by 7.30 p.m., May 6th.

Oshawa, Ont.—Mr. John Bale will receive tenders for the work of erecting a new church and Sunday School building up to noon, May 4th next.

Ottawa, Ont.—Tenders will be received until May 6th, 1912, for the construction of Azimuth Mark and Stellar Camera Huts, Royal Observatory, Ottawa. Plans, etc., at the office of R. C. Desrochers, Secretary Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received up to May 6th, 1912, for dredging required at the following places:—

Prince Edward Island—Vernon River.

Nova Scotia—Cheticamp, Margaree Harbor, Sydney Harbor, D'Escousse, Digby, Musquodoboit, Mill Cove.

Full particulars, specifications, etc., can be obtained from R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Corporation of the city of Ottawa, Municipal Electric Department, calls for tenders on fifty (50) ornamental iron lamp posts together with globes and fittings for same. Tenders to be by noon of April 30th, 1912. Specifications may be had at the office of the Electrical Superintendent, J. E. Brown, 75 Laurier Avenue W., Ottawa.

Ottawa, Ont.—Tenders, addressed to the Board of Control, will be received up to noon of April 30th, 1912, for the supply of 2,000 feet of 2½-inch double jacket-rubber-lined fire hose complete with couplings (Higbee thread). Also for the supply of two 55-gallon chemical tanks, to be constructed in accordance with specifications to be seen at the office of the Chief of the Fire Department, City Hall.

Ottawa, Ont.—Tenders will be received up to May 14th, 1912, for the supply and installation of two electrically operated pumping units each having a capacity of 2,000 imperial gallons per minute. Newton J. Ker, City Engineer, Ottawa. (See Advt. in Canadian Engineer).

Ottawa, Ont.—Tenders will be received until May 13th, 1912, for dredging required at the following places in the Province of Ontario:—South Lancaster, Gananoque, Kingsville, Blind River, Cobourg, Honey Harbor, Port Hope, Trenton, Deseronto. Combined specifications and form of tender can be obtained on application to R. C Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for interior fittings, post office, Hillsborough, N.B., will be received up to May 6th, 1912. Plans and specifications to be seen on application to Mr. B. Steeves, clerk of works, Hillsborough, N.B.; Mr. D. H. Waterbury, clerk of works, St. John, N.B., and at the office of R. C. Desrochers, secretary Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders addressed to Chas. Macnab county clerk, Court House, Ottawa, for the following road machinery, will be received up to May 6th, 1912: Two ten ton road rollers, three rock-crushers, two twenty ton bins with screen attached, and nine two-yard spreading wagons.

Ottawa, Ont.—The Board of Control will consider tenders for asphalt pavements. The tenders are to be in the hands of the secretary by 4 p.m., April 30th next.

Port Arthur, Ont.—J. J. Hackney, Commissioner of Utilities, will receive tenders for the construction of sewer and water mains to be laid on St. Paul Street. The tenders are to be in his hands by 5 p.m., April 29th.

Prince Albert, Sask.—Tenders for the various works in connection with the two four-roomed brick schools to be erected in Prince Albert for the Public School Board, will be received up to noon of April 30th. Plans and specifications can be seen at the office of the Architect, O. Albrechtsen, Prince Albert.

Scotland, Ont.—Tenders will be received until April 29th, 1912, for the construction of a reinforced concrete bridge for the Township of Oakland. Plans and specifications can be seen at the office of Fairchild and Webster, Civil Engineers, Brantford, or at the residence of Percy M. Button, Township Clerk, Scotland, Ontario.

St. John, N.B.—Tenders will be received at the office of the Common Clerk, City Hall, up to noon of April 26th, 1912, for birch or oak planking for ferry dept. Estimated quantity required is:—20,000 superficial feet 6-in. x 6-in. x 35-ft. long. Geo. H. Waring, Superintendent, Adam P. Macintyre, Comptroller, St. John, N.B.

Stratford, Ont.—The branch manager of the Canadian Bank of Commerce will receive tenders for the erection of a new bank building. He has the plans and specifications. Tenders are to be in by noon, May 6th next.

Toronto, Ont.—Plans are being prepared and tenders will be called for immediately for the erection of a ten-storey warehouse on Wilton Avenue, near Yonge Street, for the Imperial Optical Company. Building will be of reinforced concrete, and the cost will approximate $70,000.

Vancouver, B.C.—Tenders will be received up to noon of May 15th, 1912, for 2,000 lineal feet of 18-inch lap welded wrought steel water pipe and 13 double gate valves with flange ends. Specifications, etc., can be obtained from James Stuart, Purchasing Agent, Vancouver.

Varna, Ont.—Tenders will be received up to May 15th, 1912, for drainage work of by-law 11, 1911, estimated at 30,500 cu. yards. For particulars apply to John E. Harnwell, Clerk of Stanley Township, Varna.

Vernon, B.C.—Tenders will be received until May 10th, 1912, for the supply and erection, on foundation supplied by the city, of one 200 B.H.P.; 257 R.P.M. diesel oil engine for direct connection to 125 K.W., 3-phase, sixty cycle, alternating current generator with excitor. D. G. Tate, city clerk, Vernon, B.C. (See advt. in Canadian Engineer.)

Winnipeg, Man.—Tenders will be received by M. Peterson, Secretary, Board of Control Office, until April 29th, 1912, for the supply of labor and materials required in the erection of a building over the weigh scales at the Central Market. Plans, etc., at the office of City Engineer, 223 James Avenue.

Winnipeg, Man.—Tenders received by R. H. Smith, Secretary-Treasurer, Winnipeg Public School Board, up to Monday, April 29th, 1912, for the erection of a stone and brick school on Ruby and Lenor site. Plans, etc., with J. B. Mitchell, Commissioner of School Buildings, School Board Office, Winnipeg.

Winnipeg, Man.—Tenders for the plumbing, heating and ventilation fixtures required in the Dormitory Building at the Agricultural College, St. Vital, will be received up to April 27th, 1912, by Colin H. Campbell, Minister of Public Works, Winnipeg. Plans, etc., at the office of the Provincial Architect, 261 Fort Street.

Winnipeg, Man.—Tenders will be received until April 29th, 1912, for the construction of a permanent pavement, 24 feet wide, on the north side of Portage Avenue, extending from the western limits of the city of Winnipeg to the western limit of Lot 20, St. James. Plans and specifications at the Engineer's office at the Municipal Hall, St. Charles. Frank Ness, Secretary-Treasurer, Rural Municipality of Assiniboia, Kirkfield Park P.O., Man.

Board of Highway Commissioners, York County.—Tenders for the construction of Dundas Street from the city limits west to the Humber River, will be received up to Tuesday, May 7th, 1912. E. A. James, engineer to the Board. (See advt. in Canadian Engineer.)

CONTRACTS AWARDED.

Belleville, Ont.—The tender of Messrs. J. Lewis Company for water pipes was accepted by the municipal council. Their prices were lowest.

Grand Forks, B.C.—Contracts have been let for an additional 25 miles of grading on the Kettle Valley Railway west of Carmi. C. H. Williams & Co. secured a six mile contract; Milligan, Dussault & Co., nine miles; and Porter & Connelly, ten miles.

Lethbridge, Alta.—The city council have let various contracts as follows:

Sidewalk, curb and gutter, Forest City Paving Co., $22,500.

Sanitary sewers, Hotson, Leader & Goode, $26,000.

Grading, Marquard Construction Co., $25,273.

For sewer pipe, 6in., Western Supply and Equipment Co.; 8in. to 12in., J. B. Turney & Co.; over 12in., Western Supply and Equipment Co.

For steel pipe, 6in., 8in., 10in. and 12in., Western Supply and Equipment Co.; 4in., 20in., and 24in., J. B. Turney & Co.; 14in. and 18in., General Supplies Co., of Calgary.

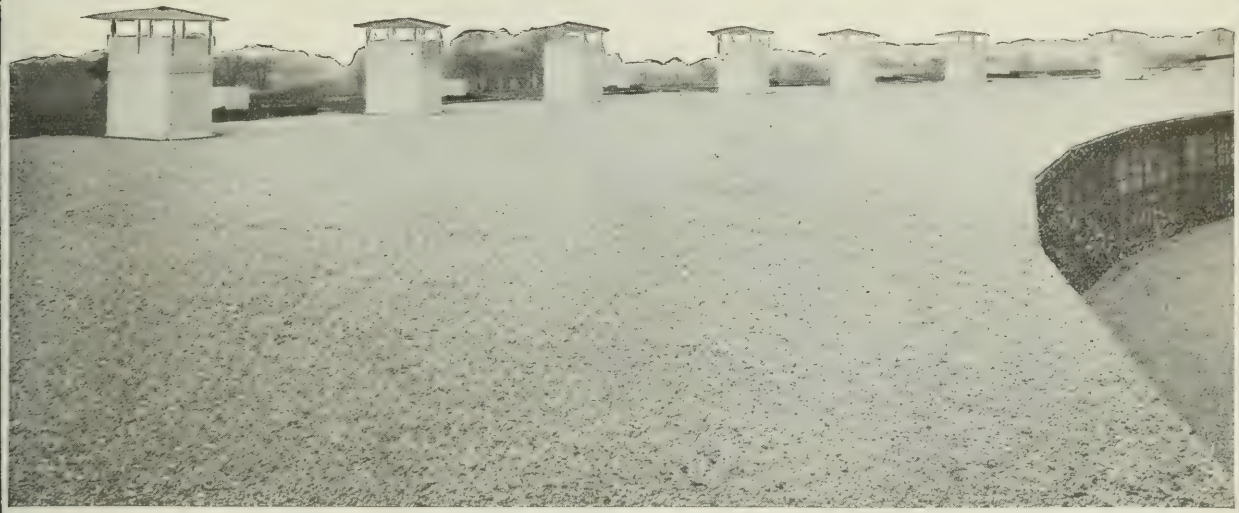
Galvanized iron pipe, Western Canada Agency; J. B. Turney & Co.; Metals, Ltd.; the contract being divided for various sizes.

Moving crane, J. B. Turney & Co.

Special piping, Crane Co.

Cement, Western Supply and Equipment Co.; price, $2.97 f.o.b., stores.

Barrett Specification Roofs



Longest Wear for Lowest Cost.

THE cost per year of service is the only true test of a roofing.

It discloses the absolute superiority of Barrett Specification Roofs. That is why on large manufacturing plants, where costs are carefully computed, such roofs are almost invariably used.

Barrett Specification Roofs are inexpensive, costing much less than tin for instance, and little more than the best grade of ready roofings.

Their cost of maintenance is nothing, for these roofs require no painting; they can't rust and they will give satisfactory protection for 20 years or more.

Insurance underwriters classify Barrett Specification Roofs as "slow burning" construction acceptable on "fire-proof" buildings.

Barrett Specification Roofs are also immune from damage by acid fumes. That is why they are used extensively on railroad roundhouses.

On cotton mills, with their humid interiors, these roofs also give perfect satisfaction, for dampness does not affect them from below.

From the viewpoint of economy and satisfactory service, no other type of roof covering compares with Barrett Specification Roofs.

That is why they have won almost universal approval for use on flat-roofed structures of all kinds.

The Barrett Specification Roof illustrated above is 50,000 square feet in area and covers the Roundhouse of the Vandalia Lines (Penna. System) at Terre Haute, Ind.

The St. Louis Roofing Co., of St. Louis, Mo., were the Roofing Contractors.

Special Note.

We advise incorporating in plans the full wording of The Barrett Specification, in order to avoid any misunderstanding. If any abbreviated form is desired however the following is suggested:

ROOFING—Shall be a Barrett Specification Roof laid as directed in printed Specification, revised August 15, 1911, using the materials specified, and subject to the inspection requirement.

Copy of the Barrett Specification, with diagrams, ready for incorporation into building specifications, free on request.

Address our nearest office.

The Paterson Manufacturing Co., Limited

Montreal Toronto Winnipeg Vancouver St. John, N.B. Halifax, N.S.

Moose Jaw, Sask.—Contract for installation of sewer and water mains has been awarded to Messrs. Patrick Kilkenny, Limited, Moose Jaw, for $19,544.59. Other bidders and prices are as follows:—Navin Bros., $22,828.23; McManus Construction Co., $22,873.60; Hurst Construction Co., Ltd., $24,058.92; W. Manders, $24,060.61. W. H. Greene, Assistant City Engineer.

Moose Jaw, Sask.—The contract for the supply of 1,000 k.w. turbo-generator set has been awarded to the Canadian General Electrical Company.

New Westminster, B.C.—The contracts for the Seventh Avenue school have been awarded as follows: Main building, Mr. William Forrester, for the sum of $32,150; plumbing work, Mr. James McMurphy; electrical work, the Parker Chase Company.

Port Arthur, Ont.—The contract for the construction of a warehouse for the Fitzsimmons Fruit Company, to be erected on the corner of Ambrose and Wellington Streets, has been awarded to Mr. Geo. Otta. Estimated cost about $30,000.

St. Catharines, Ont.—Messrs. Hitch and Company, Montreal, have been awarded the contract for the erection of the new building of the Sterling Bank in this city.

Vancouver, B.C.—Contracts for the construction of two city stables were awarded to F. J. Palo, at $3,950 each.

Vancouver, B.C.—The El Oso Paving Company have received the contract for the erection of an eight-room modern fireproof school building to cost $63,000.

Victoria, B.C.—The contract for the erection of a new municipal hall at Oak Bay has been awarded to Mr. A. H. Mitchell, for $10,500.

Welland, Ont.—Contracts for road machinery have been awarded as follows:—

One road roller, Waterous Engine Co., $2,650.

Two road rollers from Sawyer-Massey Co., $5,300.

One crusher from Sawyer-Massey Co., $1,150.

Three Champion graders, Hamilton Machinery Co., $220 each.

Three plows, Canada Foundry., $22 each.

One 25-h.p. International Harvester Co. gasoline engine (on trial), $2,000.

Five two-yard wagons, Sawyer-Massey Co., $135 each.

One six-yard spreading dump car, Port Huron Engine Co., $580.

Windsor, Ont.—Contracts for the construction of approximately 20,000 yards of paving on May and Hall Avenues, at a cost of $27,184.50, has been awarded to Messrs. Geo. Caldwell & Company.

RAILWAYS—STEAM AND ELECTRIC.

Belleville, Ont.—The municipal council have ordered tender forms prepared for 500 feet of best quality hose. J. G. Lindsay, Engineer.

Medicine Hat, Alta.—The ratepayers voted against the street railway by-law.

Montreal, P.Q.—The municipal council have received a request from the Canadian Pacific Railway that they be granted permission to erect elevated lines in several streets.

Regina, Sask.—A large water tank in the yards of the Canadian Pacific Railway will be moved to the round house. At present the tank interferes with the handling of baggage.

LIGHT, HEAT AND POWER.

Fredericton, N.B.—The Public Utilities Commission held a meeting for the purpose of fixing the power rates of the Fredericton Gas Light Company.

Moose Jaw, Sask.—The names and prices of the various firms tendering on the supply of a 1,000 k.w. turbo-generator set for the municipal power house are given as follows:—William Robinson, $25,200; Siemens Bros, $27,830 for Fraser-Chalmers combination: Siemens Bros., $27,660 for Bellis-Morcom combination: Bellis-Morcom, for the Siemens combination, $26,000; Allis-Chambers with Lancashire combination, $28,350; Bellis-Morcom, with general electric combination, $25,000; Allis-Chambers Company, with A. C. B. combination, $26,190; Canadian Westinghouse Co., proposal "A" combination, $28,888; Canadian Westinghouse Co., proposal "B," $30,070; Goldie-McCulloch, Rateau combination, $29,000; Escher-Wyss Zoelly combination, $26,000; Brush Co., $26,505; C. A. Parsons, $29,387.

Welland, Ont.—The management of the Welland Electrical Company have rejected the offer of the municipal council to dispose of their plant and property at the figure offered viz. $50,000.00. The company have agreed to appoint arbitrators at any time to confer with the city officials.

GARBAGE, SEWAGE AND WATER.

Fredericton N.B.—The Water and Sewage Committee have ordered the installation of several improvements to the pumping plant and water supply system. A new boiler and filter are included in these changes.

North Vancouver, B.C.—The municipal council have made an application to the authorities at New Westminster for the use of Lake Dick for water storage purposes. The lake is estimated to have a capacity of 220,000,000 gallons.

BUILDINGS AND INDUSTRIAL WORKS.

Brampton, Ont.—The new Pease Foundry to be erected here will comprise eleven buildings, which will aggregate a floor space of 137,000 square feet. The plans for the plant are being prepared by Messrs. Ellis & Connery, Toronto and are nearing completion. The buildings will all be of the single storey variety, except the office building, which will be two stories. They include a foundry, warehouse, shipping-room, blacksmith shop, machine shop, core rooms and ovens, rumbling room, pattern shop, pattern vault and dome and tin shop for the manufacture of furnace casings.

Calgary, Alta.—The design for the new stores of the Hudson Bay Company is something of a novelty and all stores constructed in the future will follow the same general design. There are twelve great columns across the front and the structures will be six stories in height for the present, although the foundations will be designed for a height of ten stories.

Calgary, Alta.—The management of the Winona Pioneer Tractor Company will erect a plant in this city. The site of this plant is in Victoria Square.

Edmonton, Alta.—A permit has been issued for the construction of a concrete and veneer brick plant. The plant will cost $10,000, and will belong to Messrs. Kohrg and Konig, Madgeburg, Germany.

Hamilton Ont.—A report states that the management of Pratt and Latchworth of Buffalo, N.Y., are considering the question of erecting a plant in this city for the manufacture of steel castings to be used on locomotives and cars. Mr. C. W. Sherman of Buffalo, N.Y., is at present interested in the matter.

Hamilton, Ont. — The management of the Canadian Drawn Steel Company will erect a brick extension to their present plant. Mr. Stewart McPhie, Hamilton, has prepared the plans. The cost is to be $5,000.

Hamilton, Ont.—Mr. Stewart McPhie has prepared plans for a new church to be erected by the congregation of the Congregational Church. The cost of this work will be $30,000.

Medicine Hat, Alta.—The ratepayers voted in favor of granting privileges to three new factories. They are porcelain factory, a glass factory, and a new steel works.

Moose Jaw, Sask.—The plans prepared for a new theatre, under the management of Mr. W. B. Sherman, show a building with a seating capacity of 1,500, and the cost of erecting the same is estimated at $100,000.00.

Moose Jaw, Sask.—The management of the Canadian City and Town Properties, Ltd., are about to erect a four storey building with foundations capable of supporting a weight of seven stories. It is to cost about $300,000.

Montreal, P.Q.—The authorities of Laval University have received a permit to erect a $60,000 dental college.

48 in. CONTINUOUS STAVE LINE.

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Galvanized Wire Machine Banded
WOOD STAVE PIPE
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For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

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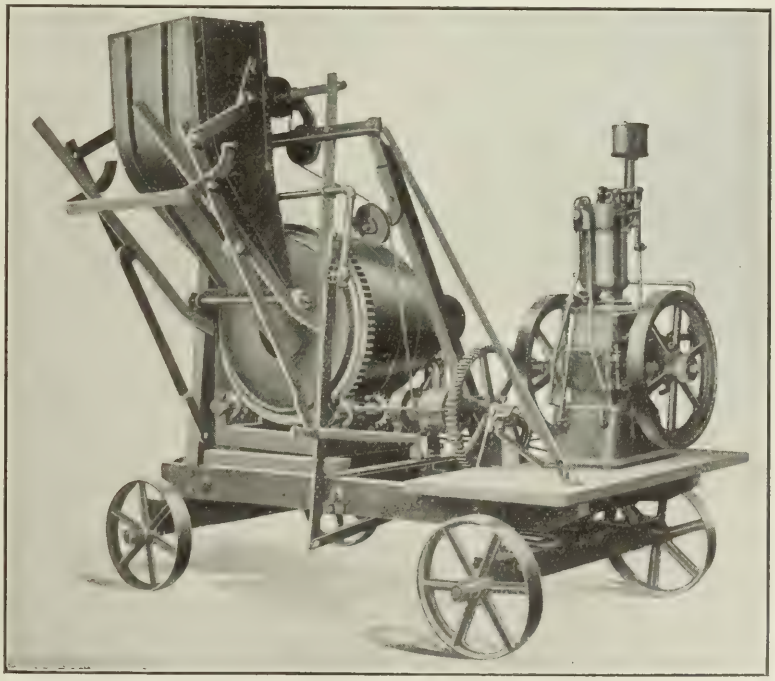

Semi-steel castings used throughout entire construction.

New automatic power dumping and new loading device, means one man operates entire machine, which gives you greater capacity, with reduced labor.

St. John, N.B.:
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15 DOCK ST.

Sales Manager for Quebec,
G. O. McDONNELL,
2059 Mance St.,
MONTREAL, QUE.

Head Office and Warerooms:
WETTLAUFER BROS. 178 Spadina Avenue, TORONTO, ONT.

Nelson, B.C.—The Brackman-Ker Milling Company will erect a business building, 2 stories, 70' × 107'. The plans include one electrical hoist, a crusher and a complicated loading platform. The architect is Mr. Alex. Carrie.

New Westminster, B.C.—The new mill of the British Canadian Company will be well equipped from a mechanical standpoint; all the machines will be operated by individual motors. Eight boilers and suitable condensers will be included in the programme. There will be about four hundred men employed.

Oak Bay, B.C.—Plans for a new municipal hall have been prepared by Messrs. James and James, Victoria. The estimated cost for this work is $10,500.00.

Ottawa, Ont.—The municipal council are considering the erection of a market in the western portion of the city. Among the alderman in favor of the project are Ald. Forward and Black.

Port Arthur, Ont.—A report states that the Northern Islands Pulp Woods Company will erect a pulp and paper mill in this city.

Port Arthur, Ont.—An extension is being built to the Prince Arthur Hotel by the Imperial Construction Company The estimated cost for this work is $45,000.

Regina, Sask.—A report states that the management of the firm of Tees and Persse, of Winnipeg, are considering the erection of a warehouse in this city.

Rosetown, Sask.—A flax mill will be erected in this town of sufficient size to employ about 75 people. It has been proposed that the mechanical part of the enterprise be so constructed that an electric light plant may be operated from the surplus energy.

Rosetown, Sask.—A Presbyterian Church will be erected in this town in the near future.

Rosetown, Sask.—The management of the Union Bank are about to erect a brick office building in this city.

Saskatoon, Sask.—A company taking the name of the Dominion Sanitarium Company has been formed in this city with Mr. C. W. Underhill as president. The management contemplate erecting in the town of Watrous a large sanitarium and hotel. These will be erected on the shore of Lake Manitou. The cost of the buildings will be about $35,000, and they will be provided with mineral baths, sun rooms, etc.

Stratford, Ont.—The ratepayers will vote and decide the question of erecting a new market building and an extension to the present fire hall. Ald. J. W. Alles is interested in the matter.

Toronto, Ont.—The management of National Drug Company have had plans prepared for a new plant to be erected at the corner of Beverley and Phoebe Streets. Mr. W. W. Bole is interested in the project.

Toronto, Ont.—A report states that the Metropolitan Engineering Company of New York, N.Y., are about to establish a branch plant in this city for the manufacture of electrical meter protective devices. Mr. Noice is to take charge of this plant. This company is a branch of the New York Edison Company.

Toronto, Ont.—Mr. D. B. Williams, 124 Baldwin Street, will erect a four storey warehouse on Spadina Avenue. The plans have been prepared by W. C. Mason.

Toronto, Ont.—The management of the Imperial Optical Company have had plans prepared for a ten-story building on Wilton Ave. The material of construction will be reinforced concrete 42' × 55'. The cost is estimated to be $70,000.

Vancouver, B.C.—The management of the Hudson Bay Company are having plans prepared for a $1,500,000 building to be erected in this city. Mr. Burbidge, Stores Commissioner, Winnipeg, Man., will arrange the details.

Vancouver, B.C.—The municipal council have had plans prepared for a rock bunker to be erected in the eastern portions of the city. It is estimated that about 100,000 cubic yards of rock and gravel will be required by the city engineer's department during the coming season.

Vancouver, B.C.—Messrs. Alexander and Brown have prepared plans for a new church to be erected by the congregation of St. James' parish. It is to cost about $100,000. Rev. Mr. Eteson is interested in the matter.

Vancouver, B.C.—The number of tall buildings in this city will be increased by the new structure to be erected for the United Building Corporation. It is to be an eighteen story structure, 120 x 100. Messrs. James Coughlan & Sons are shareholders in this company and will supply the steel work. Tenders for the remaining portions of the work and for the various supplies will be called in the near future.

Weston, Ont.—The management of the Gurney Foundry are about to enlarge their plant by the addition of extra warehouse and foundry floor space.

Winnipeg, Man.—A report states that a large grain elevator will be erected by the Canadian Pacific Railway in this city.

BRIDGES, ROADS AND PAVEMENTS.

Brantford, Ont.—Work has been commenced on a new steel bridge across the canal near the municipal water works.

Fort George, B.C.—The provincial government and the Grand Trunk Pacific have agreed to share the cost of construction of a bridge across the Upper Fraser River near this point. The structure will be so designed that it may be used for vehicular purposes as well as for railway traffic.

Lethbridge, Alta.—The municipal council, upon the advice of the City Engineer, are reconsidering the question of pavement for the lanes of this city. The ratepayers are to decide the question of gas supply, and if the by-law is carried all the mains will be buried in the lane-ways.

Montreal, P.Q.—Tenders for park improvements amounting to $35,000 will be called by the Board of Control. This work will be carried out on the Champ de Mars. Mr. Todd, landscape artist and the city engineer have revised the plans for this work.

Montreal, P.Q.—The local council of the district of Greenfield Park will spend the sum of $23,000 on road improvements.

Province of New Brunswick.—The Department of Public Works are preparing to call tenders for the construction of a number of steel bridges.

North Vancouver, B.C.—Mr. J. L. Crawford has made an application to the municipal council for permission to erect a cable bridge across Lynn Creek, about a mile south of the municipal bridge.

Quebec, P.Q.—The National Battlefields' Commission are planning to construct an important park on the Plains of Abraham near this city. Sir George Garneau, Quebec, is the president of the Commission.

Revelstoke, B.C.—It is expected that steps will be taken immediately for the construction of a motor road between Banff and Windermere. The road after leaving Banff will follow up the Bow River to Castle Mountain, thence crossing the Bow will reach the head of Vermilion River, through the Vermilion Pass in the main range of the Rockies, and following the Vermilion to the Kootenay River, will parallel this stream to a point opposite the St. Clair Pass. Leaving the Kootenay, the road will cross the St. Clair Pass, and the descent will be made to the Columbia River via the famous St. Clair canyon and Hot Springs. Mr. W. W. Foster is deputy minister of Public Works for this province.

Victoria, B.C.—Ald. Stewart, of the municipal council, has suggested that the Rock Bay bridge be planked and made safe for traffic. If this is carried out the cost will be about $2,000.

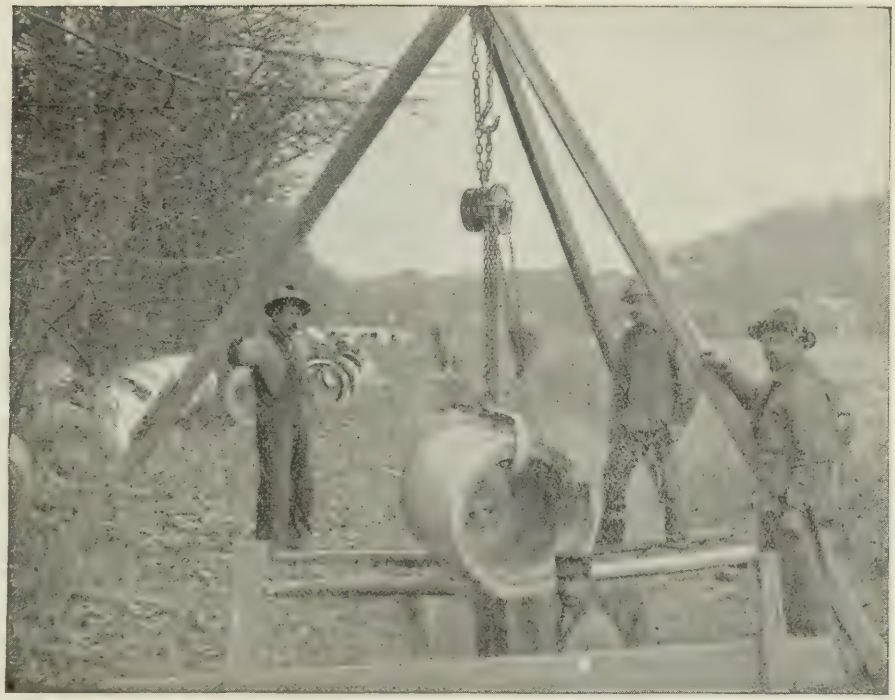
West Belleville, Ont.—The municipal council have ordered plans and specifications of a sewerage system prepared. James G. Lindsay, Engineer.

FIRES.

Hamilton, Ont.—Fire caused damage to the extent of $10,000 to the plant of the American Can Company.

Montreal, P.Q.—The warehouse and contents of Messrs. J. R. Walker and Company was damaged by fire to the extent of $25,000.

THE TRIPLEX BLOCK



A Triplex Block hung from a temporary rigging and used for laying pipe.

What is the Life of a Triplex Block?

WE don't know. Triplex Blocks built by the Yale and Towne Co. at the very beginning—twenty-five years ago—are still in actual use. The Triplex Block of to-day possesses greater lasting powers. With its steel parts—its chain superior to any other—its non-wearing gear movement—and the guarantee of a rigorous test before shipment under a fifty per cent. overload. It will outlast the man who buys it, no matter how young he may be.

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Fairbanks Standard Scales — Fairbanks-Morse Gas Engines
Safes and Vaults

MONTREAL ST. JOHN OTTAWA TORONTO WINNIPEG
CALGARY SASKATOON VANCOUVER VICTORIA

CURRENT NEWS.

Brantford, Ont.—The municipal council will secure information with a view of reducing the damage caused by the recent flood. A plan of co-operation with other municipalities along the Grand River for the erection of storage facilities to prevent flooding is being considered.

Moose Jaw, Sask.—What might be considered a record in building construction has been performed in this city. The Robin Hood Mills were in operation after less than three weeks construction. The building is a seven story structure, 54 × 112.

Regina, Sask.—The municipal board of trade are taking steps to interest local business men in a large coal district in this vicinity. Mr. G. S. Porter, Regina, is interested in the project.

PATENTS.

The following is a list of patents recently granted to inventors in Canada. The list is furnished by Messrs. Featherstonhaugh & Co., Royal Bank Building, Toronto:—G. F. Brown, capstans; G. E. Goldstein, process of seasoning cigars; N. P. F. Death, illuminated signs; A. Hutchinkins, acetylene gas generating machines; G. Low, jr., push button electric switches; A. J. Lavoie, internal combustion engines; T. G. McGonigle, rotary engines; H. J. S. Martin, universal joints for fluid pipes; W. D. Seale, street indicators; T. M. Stewart, valves; A. B. Surarus, street indicators; A. Warrell, asbestos packing; J. Wright, lanterns.

THE AUSTRALIAN TRANSCONTINENTAL RAILWAY.

The government of this country will undertake the construction of this great work without the assistance of a contractor

British manufacturers of railway material will probably receive a considerable preference in all iron goods, and makers supplying internal combustion engines should obtain ample opportunities of demonstrating their ability to compete on favorable terms with American enterprises. Tenders are now being invited (in London and Australia only) for 135,000 tons of steel rails. They must reach the high commissioner's office in London by 2 p.m. on May 29.

About 2,000 men will be engaged on the work, 1,000 starting at each end. The two parties will meet in the middle of the route in a desert and will have to be supplied with water at enormous cost. The gangs will need to be accompanied by camel commissariat corps, and will for many months encounter grave risks. The line is to be 1,070 miles long, and in the opinion of Mr. King O'Malley, the Labor minister for home affairs, is the longest that has been ever undertaken as one job.

Within five years, Regina, Moose Jaw, and all the municipalities within the Soo Line district to Weyburn will be securing water in the Saskatchewan River by means of the Government system. Such was the prediction of Mr. T. Aird Murray, Toronto, consulting engineer, who is at present engaged by the Saskatchewan Government in connection with the proposed system of water distribution from the Saskatchewan River. The minimum daily flow of the Saskatchewan River is 1,800,000,000 gallons of water, and of that quantity all that will be required to serve the purposes planned by the Government will be 300,000,000 daily.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16304—April 11—Directing C.P.R. to construct a station and appoint an agent at St. Francois de Salle, Que., and to file plans within 30 days showing side track.

16305—April 12—Directing C.P.R. on or before May 1st, 1912, to make Winchester, Ont., regular stop for trains 21 and 22.

16306—April 12—Naming express collection and delivery limits for town of Chapleau, Ontario.

16307—February 15—Approving C.N.O. Railway branch line to Bond St., and spur line into William St., Oshawa, Ontario.

16308—April 15—Granting certificate of correction to G.T.P. B.L. Co., correction location plan Regina Boundary Branch.

16309-10—April 13—Authorizing C.P.R. to reconstruct bridge No. 24.5 on its Macleod Sunbdivision and bridges 33.9 and 103.9 on its Edmonton and Muskoka Subdivisions.

16311—April 15—Approving location of Central Railway Company of Canada from Oka at mileage 31 to south side of highway at Carillon at mileage 45.61 (Montreal to Midland Line).

16312—April 3—Authorizing C.P.R. to cross with additional track, track of Street Railway at Pacific Avenue, Fort William.

16313—April 11—Directing C.N.R. to construct road crossing, etc., and grade roadway to loading platiorm, elevator and team track by 1st May, 1912, under penalty of $10.00 per day. At Polly, Sask., complaint, Board of Trade.

16314—April 12—Directing that Supp. No. 6 to G.T.R. Tariff C.R.C. No E. 1432 and Supp. 5 to C.P.R. Tariff C.R.C. No. E. 1286 may become effective June 1st, 1912, re Order 15844 January 27th, 1912, Consumer's Cordage Co., Ltd., Mtl.

16315—April 12—Directing C.P.R. to construct suitable farm crossing for F. W. Dodwell, of Austin, Man.

16316—April 13—Authorizing C.P.R. to construct spur for William Davies Co., Ltd., near Front and Overend Sts., Toronto, Ontario.

16317—April 13—Granting certificate of correction to G.T.P. B.L. Co., error in location plan Regina-Boundary Branch.

16318—April 13—Authorizing G.T.R. to construct siding into premises of Ridgeway Milling Co., Ltd., Ridgeway, Ontario.

16319—April 12—Authorizing G.T.R. to construct additional track across Pape Avenue, Toronto, Ontario.

16320—April 13—Approving revised location of C.N.R. (Calgary-Strathcona Branch) mileage 72.58 to 81.75, Alta.

16321—April 15—Approving joint agreement between C.P.R. and C.N.R. for joint facilities at Regina, Sask.

16322—April 15—Approving location of C.P.R. station to be erected at Cutknife, Sask.

16323—April 12—Directing C.N.O. Ry. to install electric bell at crossing, Manvers Road, 1st highway east of Bowmanville Station, Ont. Complaint, James Veal.

16324—April 15—Directing Dominion Atlantic Rly. before 1st July, 1912, to install electric bell a short distance east of Berwick Station, N.S. Complaint, John Buchanan. 20 per cent. from Railway Grade Crossing Fund.

16325—April 11—Approving location of Campbellford, Lake Ont. & Western Ry. Co., Glen Tay, to Cobourg Line, from mileage 88.21 (from Glen Tay) to mileage 106.17, and to take possession of certain portions of G.T.R. right-of-way.

16326—April 13—Approving location of James Bay & Eastern Rly. (C.N.R.) station grounds at Demeules, Que.

16327—April 15—Authorizing C.P.R. to construct additional tracks across highways at Tantallon, Esterhazy and Killaley, Sask.

16328—April 12—Re King St. crossing C.P.R. at Walkerton, Ont., crossing to be widened; bell question reserved for further consideration of Board.

16329—April 15—Authorizing G.T.P. Ry. to construct spur for Edmonton Portland Cement Company, Ltd., near Edmonton, Alta.

16330—April 15—Authorizing C.N.O. Ry. to construct bridge across the Muskegogama River at mileage 94, from Sudbury Jct.

16331—April 18—Amending Order No. 13357 of March 30, 1911, as follows:—"Express Companies are absolved from making delivery under the terms of this Order where the condition of the roads or streets is not in a reasonably passable state for vehicular traffic."

16332—April 17—Authorizing M.C.R. to reconstruct bridge No. 180.52 over Grand River.

16333—April 16—Approving character of work known as "the Hill Drain" across Pere Marquette Ry. being constructed by Twp. of Aldborough, County of Elgin, Ont.

16334—April 16—Approving location of C.N.Q. Ry. station at Cap Sante, Que.

16335—April 17—Approving Plan "B" in connection with grade at Jackson St., Bethany, Ont., C.P.R. (G. B. & S. Ry.), and rescinding Order 16115 of March 13, 1912.

16336—April 17—Approving location of C.P.R. station at Claresholm, Alberta.

16337—April 17—Authorizing C.P.R. to construct 9 spurs for Birds Hill Sand Company near Winnipeg, Manitoba.

16338—April 13—16339—April 15—Approving location of G.T.P. B.L. Co. stations to be known as Bremen and Meacham, on its Prince Albert Branch; and Stony Beach and Keystown, on its Regina-Moose Jaw Branch.

16340—April 17—Authorizing G.T.R. to construct spur for Barber-Ellis, Ltd., in city of Brantford, Ont.

16341—April 17—Directing C.P.R., G.N.W., and C.N.R. Telegraph Companies to deliver telegrams within corporate limits of city of St. Boniface, Man., free of charge.

16342—April 18—Authorizing G.T.R. to construct spur for Connell Anthracite Mining Co., Ltd., Carlaw Ave., Toronto.

16343—April 18—Approving plans of C.N.R. Standard Portable Station for use on Eastern Lines.

16344—April 18—Approving location of James Bay & Eastern Ry. (C.N.R.) station grounds at Chute A. L'Ours, Que.

16345—April 18—Dismissing application of Stockton & Mallinson, Regina, Sask., re Dominion Express rates.

16246—April 18—Authorizing city of Fort William to construct Pacific Ave. across C.P.R.

Volume 22. Toronto, May 2, 1912

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The Canadian Engineer

An Engineering Weekly

DISCHARGE CAPACITY OF SAFETY VALVES.

The February issue of The Journal of the American Society of Mechanical Engineers contains the results of some tests made upon Crosby safety valves by Prof. E. F. Miller, of the Massachusetts Institute of Technology.

The tests were made to determine the discharge capacities of 3-and 3½-in. locomotive pop safety valves, Fig. 1, at varying lifts under 200 lb. steam pressure and of corresponding sized inspector valves of the flat-seated and bevel-seated types, Figs. 2 and 3, under 100 and 150 lb. steam pressure. In each case the spring was released by a spindle and the valves were set a definite distance from their seats. In order to avoid unequal expansion, the metal of the valve body and that of the spindle were made the same in the case of the locomotive valves; and the difference in expansion was similarly obviated, as far as possible, in the inspector valves.

Connection was made to the boilers through a 5-in. line and all the discharge was condensed in a surface condenser and weighed.

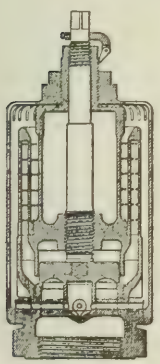


Fig. 1.—Muffled Locomotive Type.

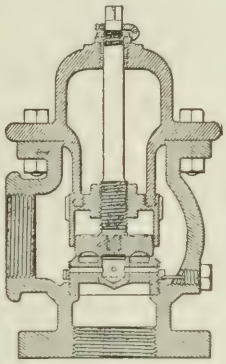


Fig. 2.—Flat-seat Inspector Type.

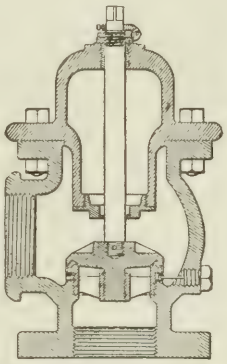


Fig. 3.—Bevel-seat Inspector Type.

The additional lift due to the yielding of the metal because of the presence of steam pressure on the under side of the valve was determined in each case by placing the valve in a testing machine and subjecting it to a load corresponding to the steam pressure, the movement of the valve with relation to its seat being measured by a micrometer caliper.

The results of the tests are plotted in Figs 4 and 5. As a result of these tests the muffled locomotive pop safety valve is now made as shown in Fig. 6.

In an addendum to Prof. Miller's paper, Mr. A. B. Carhart, of the Crosby Steam Gage & Valve Co., makes some general comments regarding pop safety valves. Quoting in part these remarks, he says:

"Pop safety valves were invented about 60 years ago and about 30 years later were perfected in this country and went into general use. Broadly, the invention consists of an addition to the disk of the valve so that when the valve is closed the addition is excluded from the action of the steam. However, when the valve opens the outflowing steam acts upon it and with the initial force causes the valve disk suddenly to rise higher and the spring to be compressed more than it would be with a force due to the steam pressure acting upon the original area only.

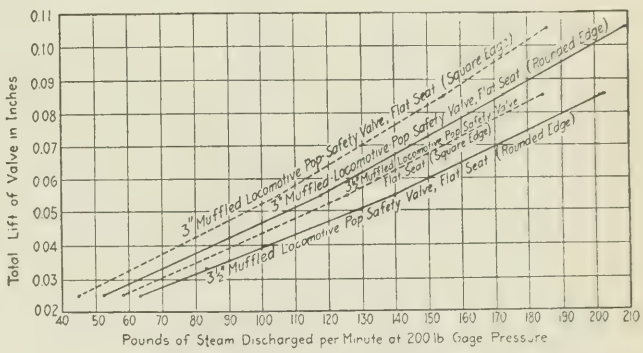

Total Lift of Valve in Inches
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210
Pounds of Steam Discharged per Minute at 200 lb Gage Pressure
3" Muffled Locomotive Pop Safety Valve, Flat Seat (Square Edge)
3" Muffled Locomotive Pop Safety Valve, Flat Seat (Rounded Edge)
3½" Muffled Locomotive Pop Safety Valve, Flat Seat (Square Edge)
3½" Muffled Locomotive Pop Safety Valve, Flat Seat (Rounded Edge)

Fig. 4.—Results of Tests on Locomotive Type of Pop Safety Valve.

"The bevel-seated valves (Fig. 3) generally have this additional area at the periphery of the disk, outside of the seat, where it forms a chamber with a more or less contracted outlet at the extreme lip of the valve, through which all the steam must pass after escaping over the seat before it reaches the open air.

"As the seat is formed at an angle of 45 deg. to the vertical, the passage between the seat and the disk faces, when the valve opens, is diagonally upward, and what is called the lip of the valve is so related to this seat that the

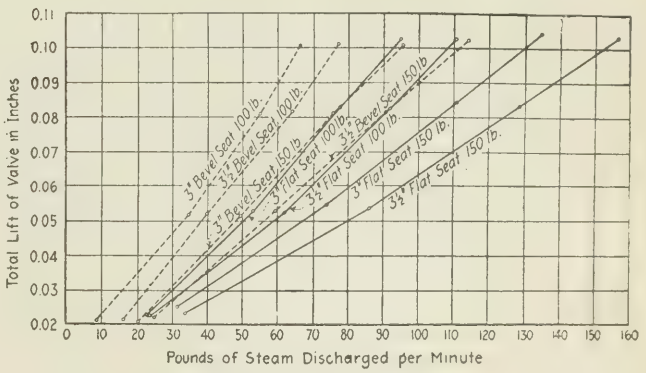


Fig. 5.—Results of Tests on Inspector Type of Pop Safety Valve.

steam is forced to impinge directly upon it before being deflected downward toward the bottom of the chamber where it reacts. The effect of the impact upon the lip of the valve is increased by the expansive force of the steam acting in the lip chamber on account of the partial and momentary

confinement before it passes into the open air. Sometimes openings are made through the lip or in the floor of the chamber, through which the steam escapes and so reduces the pressure within the lip chamber that the valve disk will not lift too high.

"Annular valves have the additional area located at the centre of the disk and within the outer seat. This area is excluded from the action of the steam when the valve is closed, by means of an inner seat, but is acted upon directly by the steam when the valve opens. The disk is simply a flat cover for the valve base and has two concentric seats

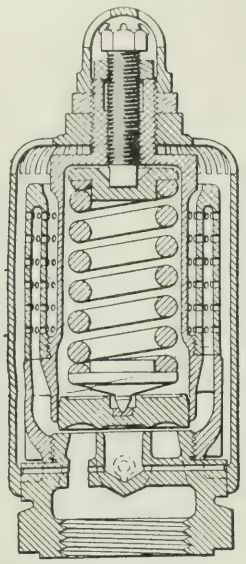


Fig. 6.—Muffled Locomotive Pop Safety Valve as Now Made.

in the same horizontal plane. The central area of the disk, which is not exposed to the steam when the valve is closed, covers a well which communicates to the outer air through four hollow arms radiating from it out through the sides of the valve body.

"When the valve opens, the steam is discharged directly across the outer flat seat, and there is also a separate additional flow over the inner seat into the central well and out through the four hollow arms. The openings through these arms are controlled by a sleeve, threaded on the valve body, so that it may be turned upward or downward as desired. If it should close the open ends of the hollow arms, preventing the escape of the steam through the central well, the reactionary effect upon the disk to lift it against the spring would be greater than if the openings from the well were unobstructed; and by locating the sleeve at intermediate points the lift of the valve can be varied.

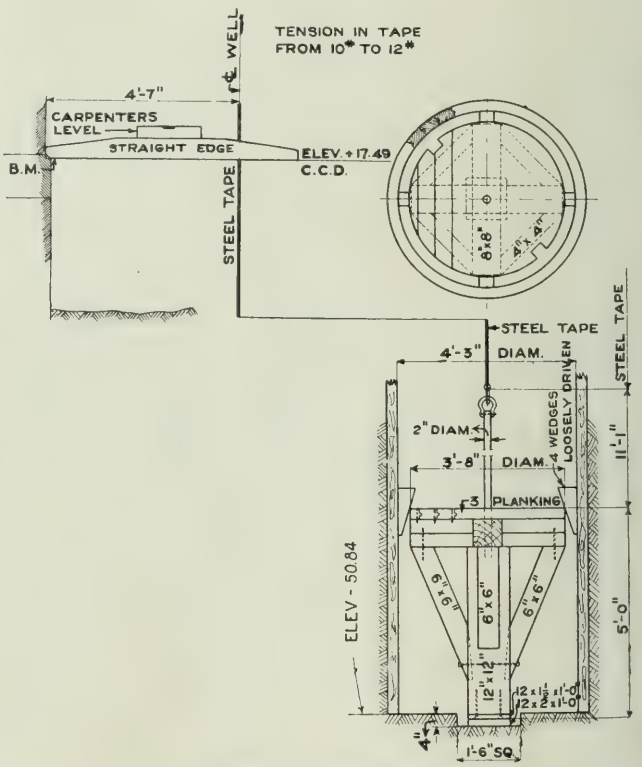
"In bevel seated valves the disk is ordinarily guided vertically so that it will return properly to its seat when the valve closes, by means of four or more radiating wings or vanes extending from the face of the disk in the steam space and bearing against the sides of the inlet or throat of the valve. But in the annular valve there are no guides or wings attached to the disk, which is simply a flat member having the truncated form of the central zone of a sphere.

"This is placed in a cylindrical chamber outside and above the steam space, and there it lifts or moves freely as acted upon by the steam against its lower face and by the opposed spring which presses upon it at its centre. The contact between the chamber and the spherical part of the disk is the least possible, which permits universal movement of the disk without possibility of cocking or sticking, and yet insures that the disk will return accurately upon its seats when the valve closes."

TESTS ON HARDPAN.

Hardpan and rock underlie the clay bed on which a large portion of the city of Chicago is located. Deep building foundations generally are carried down to one of these materials, the standard construction being wood curbed circular wells excavated down through the clay bed and filled with concrete. No tests are recorded as having been made on the bearing power of Chicago hardpan, despite its frequent use as a foundation bed, until the construction of the Cook County Hospital was undertaken. The following is an abstract of discussion before the Western Society of Engineers, by Mr. Frank A. Randall, chief engineer for Morey, Newgard & Co., who are engineers for the work.

The preliminary borings were made 6 ins. in diameter for about 30 ft. in depth and 3 ins. for the balance of the depth. These borings show below yellow clay a thick stratum of "soft sticky clay" down to about 37 ft. below ground level, with solid blue clay running into "hard clay and gravel" down to hardpan at an average of about 47 ft. below ground at the south end and 56 ft. below ground level under the main building. The main building is about 550 ft. long by 70 ft. deep, and has four pavilions, 40 ft. by 200 ft., projecting from the rear. The ground area covers



Details of Apparatus.

about 75,000 sq. ft. Rock was shown according to borings at elevations —67 and —89.5 in two cases, but the latter figure was assumed to be the more reliable. Because of the great difference in cost between caissons to hardpan and to rock and the size of the loads to be carried, it was decided to use hardpan caissons, provided the test showed a satisfactory layer of hardpan, with rock in the same relative location as in the preliminary borings. Bids were received also for pile foundations, but as the prices for these amounted to some $13,000 more than those for caissons, the latter were used. The caissons tested were carried on down after the test to determine the thickness of the hardpan stratum and the depth to rock. The hardpan was found to be from 15 to 20 ft. in depth, with hard clay

and gravel beneath, and rock was found at elevation —90, below ground level.

The test was made in caisson No. 163, which was 4 ft. 3 ins. in diameter and 64.7 ft. below ground level, or at an elevation of —51.17 ft., Chicago City Datum.

The apparatus consisted of a loading platform, extra bearing plate, wedges, 12-ft. rod, steel tape, straight edge, carpenter's level, platform scale, 13 tons of pig iron and tripod with drum for raising and lowering pig iron. The apparatus as used is shown on the screen.

The timber loading platform consisted of a central post 12 x 12 ins., with two 8 x 8 pieces crosswise at the top and covered with 3-in. planking. The post was shod with a steel plate 12 x 12 square by 1½ ins. thick. The extra bearing plate was a steel plate 12 x 12 x 2 ins., and was used beneath the loading platform, resting directly on the hardpan. Four wedges were used to steady the platform, loosely placed, as shown in the sketch. (See Figure.)

The steel rod, 2 ins. in diameter and about 12 ft. long, sat in a babbitted hole, 14 ins. deep, in centre of the platform. To the upper end of this rod the steel tape was attached. The rod projected up through the pig iron and thus permitted the tape to be unfastened while pig iron was being lowered into well. The tape was an ordinary steel tape, graduated to feet and inches.

The straight edge was as shown in detail and was found perfect when tested by reversal of the carpenter's level, which latter was of more than ordinary sensitiveness and accuracy. The platform scale was obtained from the hospital and was found correct by checking same against known weights. Thirteen tons of pig iron was on hand, but only about twelve tons of this was used, this amount being considered sufficient by all concerned. The tripod was of ordinary construction, such as was used on the work for excavating and filling wells.

Water had been standing in the well for several days and this water was removed Friday morning, on Jan. 26th. It is also necessary to deepen well between 2 and 3 ft. in order to remove earth which had been softened by the standing water.

As soon as this was done a hole 4 ins. deep and about 18 ins. square was dug in the centre of the bottom of the well and the bottom carefully cleaned and leveled. The extra bearing plate was then set, leveled and centred in this hole. It had been intended to enclose the central hole in a wooden box of four sides, to be backed up with concrete and clay to keep all water out of hole, but water sprinkled in from above directly into hole, so this had to be abandoned.

At 5.30 p.m. (Friday) a start was made at lowering the platform, but due to the fact that the platform had to be rotated so that notches would clear lugs in rings of lagging, the platform was not in place until 7.25 p.m. Platform was raised and dropped several times onto bearing plate in order to force out as much as possible of the earth which had sloughed off into hole.

Loading of pig iron onto platform was begun at 8.40 p.m. Pig iron was weighed out in batches averaging about 600 lbs. as fast as lowered and placed. The pigs were of varying size and were placed in layers of stretchers and headers radiating toward centre and bonded together in addition by small pieces of wood as deemed necessary. No pig iron was placed closer than 1½ ins. of the lagging, the pile when completed being about 4 ft. in diameter and a little over 12 ft. high.

Five readings were taken at intervals, the method being as follows: A permanent bench mark was established upon water table of present hospital building, within 4 ft. 7 ins. of the centre of well. Elevation of B. M. = + 17.49 C. C. D. This was leveled across from the B. M. to the tape by means of straight edge and read tape to the nearest 1/16 in.

The readings taken were as shown in the following table:—

Time.	Load.	Reading Ft.	Ins.
Jan. 27—			
12.15 a.m.	4,079	52	4½
6.30 a.m.	10,887	52	4 15/16
9.35 a.m.	17,362	52	4 15/16
12.00 a.m.	23.189	52	4 15/16
Jan. 28—			
9.00 a.m.	24,189	52	5⅛

The well tested was a very wet one, due to the fact that two sewers, 6 and 9 ins. in diameter, were cut into in sinking. This well was the wettest one encountered. From about 12 ft. to 14 ft. of water stood in the well during test.

When the platform and bearing plate were removed it was noted that ⅛ in. of compressed earth adhered to top of loose bearing plate.

The caissons were designed for 44,000 lbs. per square foot at top of caisson and were belled twice the diameter of the shaft. Considering hardpan at 60 ft. below the surface, the unit designing load on the latter is about 13,300 lbs. per square foot, or about one-half of the test load. The test load was applied to 1 sq. ft., while the area of the well was about 16 sq. ft. It is not known how much bearing value of the hardpan is increased when the caisson is completed and the well completely filled, but it must be a very material increase. The results indicate that the hardpan stratum will carry the load designed for with safety. Doubtless a portion of the settlement was due to the compression of the loose soil which sloughed in as platform was being lowered.

The test was conducted by Morey, Newgard & Co., under the personal supervision of the author. The W. J. Newman Company, contractors for the caissons, supplied labor and material. The total cost of the test was $400.

GROUND WATERS.

Underneath the surface of the earth is a vast body of water which may be likened to an underground lake, called the ground-water. It is into the upper surface, frequently termed the water-table, of this ground-water that wells are sunk for domestic and other water supply. In "The Water Powers of Canada," issued by the Commissioner of Conservation, it has been estimated that, if all the moisture resident in the upper 100 feet of the ground were collected, the amount would be the equivalent of a lake of water some 17 feet deep; that is, the equivalent of about seven years' rainfall. During periods of plant growth this ground-water yields, chiefly by capillary action, part of its moisture to the plants; and then, during seasons of excessive rainfall, is again replenished from the rainfall. The annual fluctuation in level of the ground water-table under normal conditions is but a few inches.

The underground waters of Canada, in some places, are now being tapped and wasted. State after State, in the United States, has enacted laws designed to conserve the underground waters.

BRITISH ENGINEERS ARRIVE.

The engineering party, under the direction of Mr. Henry W. Crees, of London, Eng., arrived in Montreal on Saturday, April 27th last, by the Canadian Northern liner Royal George.

CONCRETE FENCE POSTS.*

By L. J. Hotchkiss.†

A paper on this subject should include a description of the more important types of posts so far developed and a discussion of their merits. It has not been possible, however, in the time available to get together the information for such a paper. I shall, therefore, confine myself to the one post with which we have had experience on the Burlington Railroad.

The machine was set up in 1911 and a small number of posts, about 6,000, were made. It has now been put in operation for this season's work, but has been running only a few weeks.

In going into a new proposition of this kind there are always some delays in getting the plant organized and operating smoothly. We have had the usual amount of trouble along this line and have not yet been able to determine how cheaply we can make posts.

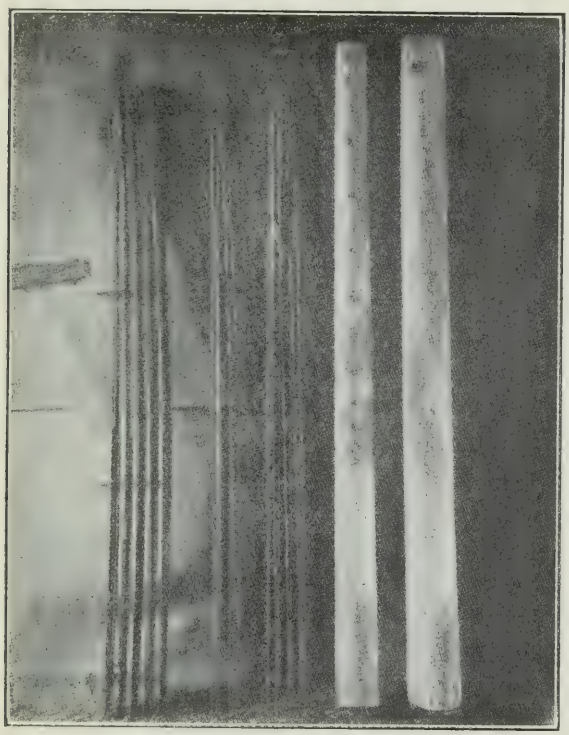


Fig. 1.

With the plant as now arranged, the machinery is all enclosed in a frame building 28 feet by 94 feet. The concrete materials are brought into the house at the rear of the post machine and storage room is provided in the house for a considerable quantity of material so that it may be warmed for use in cold weather. The drawing shows piles of stone chips and sand. The chips, or screenings, were tried experimentally because they could be obtained at practically no cost. They were not satisfactory, however, as the concrete seemed to lack strength and the posts were not smooth. A mixture of sand and screenings was tried, with somewhat better results.

A supply of small gravel containing a large proportion of sand was then obtained and this material is superior in every way to the others mentioned. It can be obtained in any desired quantity and at a moderate price, and will undoubtedly form the standard material for this work.

As the posts are taken out of the machine they are placed on a push car standing on the track shown at the upper part of the drawing. In cold weather they are stored in the house for a few days before being taken out of doors. In warm weather they are stored indoors or out, as may be most convenient. They are removed from the moulds a day or two after being made and stored against the heavy timber racks until ready for shipment or until they are strong enough to be corded up in piles. For a week after being removed from the moulds they are thoroughly wet down once a day and in summer protected from the sun by tarpaulins.

In the rear of the post machine is the measuring machine, consisting of two hoppers for gravel and cement. A small conveyor operates in the bottom of the hoppers and dumps the materials in proper proportions into a boot. Here it is picked up by a bucket elevator and taken to the mixer at the top of the machine.

The mixer is a large shallow bowl with a concave bottom. A number of paddles rotate in this bowl and mix the concrete, water being sprayed on it from a perforated pipe. In the bottom of the mixer is a hole which is closed by a form of gate valve, and through which concrete is discharged into the moulds below.

Under the mixer is a turntable arrangement which holds four moulds at a time. There is also a jolting device so arranged that as each mould is being filled it is alternately raised and dropped through a distance of perhaps an inch. This tamps the concrete effectually and insures a smooth finish.

Two forms of reinforcement are used. The one which was used last year is made from sheets of No. 24 or No. 26 black iron. The sheets are passed through a machine which cuts out half the reinforcement for a post at each pass. At the same time long slits are cut in the iron and the edges of the slits turned up. Two strips of this material are inserted in the mould to form the reinforcement for one post.

It has not been altogether satisfactory, however. If the concrete material is a bit too coarse it does not run through the slits readily and the posts are not well filled out. The reinforcement also has a tendency to get out of place during filling and is occasionally found to be near the centre of the post instead of at the outside.

Fig. 1 shows an improved style of reinforcement now coming into use. It is made entirely of wire, each wire being crimped to insure a bond with the concrete. The material is shipped knocked down, as shown at the left of the photograph, and is quickly made up into the cages shown at the centre. The wires may be of such size as needed to give the required strength and the concrete flows around it without obstruction.

Fig. 2 illustrates the post and also the method of fastening the wires to the posts. By reference to the cross sections it will be seen that there is a groove in one side of the post and that the holes through the posts are offset, being smaller on the grooved side of the post. These holes are of such a size that a ten-penny nail can be pushed through them until the head brings up against the offset. The fence wire is then placed on top of the projecting end of the nail and the latter bent up around the wire until its point is curled back into the groove, thus holding the wire tight against the post. This work is done with a small tool which is shown in successive positions in the upper part of the drawing. This is a very cheap and effective fastening. One difficulty has developed in connection with it, however.

* A paper before the Eighth Convention of the National Association of Cement Users.

† Assistant bridge engineer, C. B. & Q. Railroad, Chicago.

The pins with which the holes through the post are made are necessarily all alike. The post is tapered. As a result the small part of the hole through which the shank of the nail passes is longer nearer the bottom of the post than at the top. Consequently the nails at the top stick out too far and when bent around the fence wire the points strike the bottom of the groove and make it difficult to pull the wire up close to the post. A tapered strip is now attached to the outside of the mould under the heads of the pins. It is of such a thickness that the offset in the holes is a uniform distance from the grooved side of the post and all nails project the correct distance to insure proper fastening of the wire.

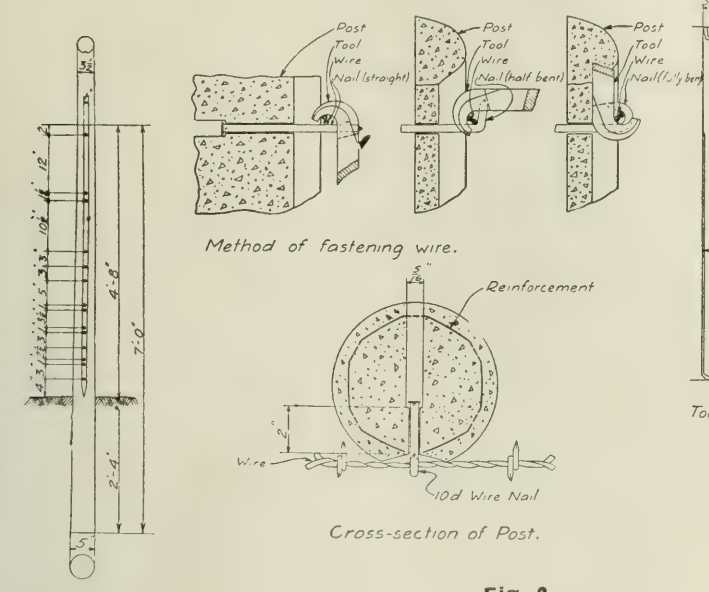


Fig. 2.

Another method of fastening the wires is shown in Fig. 3. It will be seen that the hole through the post is of uniform diameter and a piece of wire with one end doubled back is substituted for the nail. The other end of the wire projects at the back of the post, and by means of the tool shown this is twisted up into a corkscrew. The fastening has not yet been tried out in practice, but its use on an experimental post seems to indicate that it is simple and efficient. It was designed for use with a round post having no groove. As our moulds are all grooved, we expect to use it with this type of post.

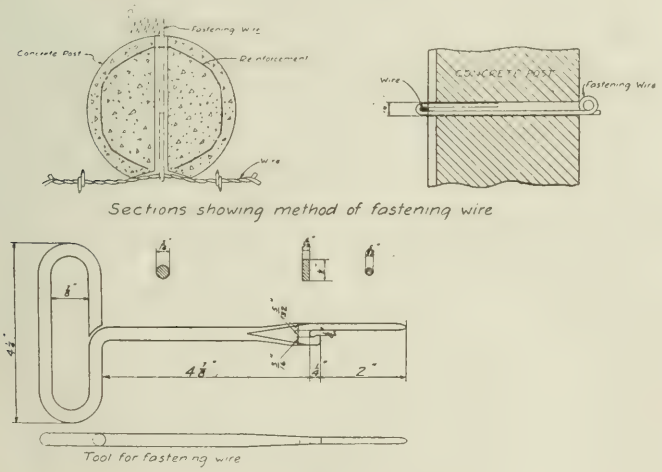


Fig. 3.

The annual consumption of cedar posts on a large railroad runs into hundreds of thousands. Rot and grass fires eat them up, unruly steers break them off and the ever-present hobo finds them good fuel for his campfire, provided he can get them without too much labor. None of these agencies except the steer have any effect upon concrete posts and there is a large field for their use. They must be produced cheaply and in large quantities, however, and must be strong enough to stand rough handling as well as to resist the forces which come upon them in service.

The machine we are using will turn out 400 posts per ten-hour day. As previously stated, we do not yet know how low the cost can be gotten, but we are satisfied it can be made such that they will compete with cedar posts.

It must not be expected that a concrete post will stand the degree of rough handling which can be given a wooden post. It is easy enough to make them strong enough to withstand the loads which come upon them in a fence and they are in no sense fragile. But some degree of care must be used in handling them or cracked posts will result.

If they are used with the same degree of care and intelligence required in any other form of permanent construction it is very certain that most satisfactory results may be obtained.

TRACK ELEVATION AT MONTREAL.

Montreal is still awaiting an arrangement with the Grand Trunk Railway regarding the elevation of the company's tracks. It is now at least three or four years since the matter was taken up seriously, it having been in the realms of discussion for years previous to that. Some few years ago, however, the company and the city got as far forward as to discuss plans. Plans were even drawn up, and, if not actually approved of, were at least given favorable consideration. At the present time, the railway passes into the city from the west on a surface track, the crossings being very numerous, and being on a level with the street. The track coming up from the south crosses the Victoria Bridge and joins the track entering the city from the west. The work of elevating the tracks will naturally be very costly, and this may, to a considerable extent, explain the many years' delay which has taken place in carrying out the work to completion.

The whole subject was to have been taken up at the last meeting of the Railway Commission, held here a few days ago. The city had previously consented to contribute $2,000,000 towards the work, and it was generally thought that the railway regarded this as sufficient. In fact, it was generally understood to be the sum originally asked by the railway. Now, however, the Grand Trunk expresses its dissatisfaction at the amount, the work being much more costly than previously supposed. The public do not quite understand why the city should pay anything towards elevating railway tracks, but the principle seems to have been accepted by the city council. The Commission will deal with the matter at its next meeting.

INVESTIGATION AND CARE OF RETURN RAILWAY CIRCUITS.*

By E. E. Nelson.

In the early days of electric railroading it was supposed that the earth had zero resistance on account of its area being practically infinity. This was soon found to be far from the truth. As the number of cars operated increased the drop in voltage become so large that it was found impossible to move the cars, and means had to be taken to help out the earth return. In some cases a copper return was laid in between the tracks and frequently joined to the rails. But with the heavier loads and greater distances, the cost of this becamt prohibitive. Means were then taken to utilize the great carrying capacity of the rails themselves. This was done by bonding the rail joints together by means of copper wire fastened into holes drilled in the rails. This work was usually left to the track department who assigned it to the cheapest paid workmen. These men did the best they knew how, but it was a better mechanical than electrical job which was put out by such men. Now it is intended by all electric railways to use the track rails for the return of current from the cars to the power house. But on account of the rails being in close contact with the ground such railways use both the rail, ground, and material buried in the ground for their return circuits.

When a steam engine, electric generator, motor, or similar machinery breaks down, the electric railroad manager is notified in a very forcible manner, but when his rail bonds are in poor or only fairly good condition, there is no startling notification. Perhaps he notices that the power at the cars is usually weak and he notifies his power house that they are not holding up the voltage. Or he jumps to the conclusion that his feeder capacity is too small a section, and on the spur of the moment strings in additional feeders without any great benefit. Or possibly he may notice at the end of the month or year that the kilowatt-hour per car-mile on his road is much larger than that expended by his associates. To remedy this he may get after his transportation superintendent and tell him that the motormen are very wasteful with the power. All these troubles in addition to many more that might be mentioned are likely to be caused by poor track bonding.

It is realized by practically all railway managers to-day that unless extreme care is taken with the return circuits the losses in these circuits will become enormous; even enough to make the difference between a road paying and not paying dividends.

Rail steel is a very good conductor. Weight for weight it is about one-seventh as good a conductor as copper. A copper wire bar weighing 1 lb. per yard has an area of about 110,000 cir. mils, hence an iron bar weighing one pound per yard is equivalent to about 16,000 cir. mils copper. The resistance of 16,000 cir. mils copper is approximately 0.6 ohm per 1,000 feet. Therefore, the resistance of a steel rail in ohms per thousand feet is equal to 0.6 divided by the weight of the rail in pounds per yard, and the carrying capacity of the steel rail in circular mil copper equivalent is equal to 16,000 multiplied by the weight of the rail in pounds per yard. Seventy pound rail, which is the size commonly used in street railway work, therefore, has a carrying capacity equal to 1,120,000 cir. mils copper. In order to use this great copper equivalent carry capacity, it is only necessary to bond the rails themselves electrically together. This is now usually done by the following types of rail bonds: expanded terminal copper bonds; soldered, brazed or welded copper bonds; amalgam bonds; and by means of welding the rail joints themselves together by either a cast, electric or thermit weld.

A rail bond has its greatest resistance where it comes into contact with the rail. If the steel has a resistance of seven times that of copper, the area of the contact between the bond and the rail should be seven times the area of the bond. In the expanded terminal copper bonds using the ordinary T-rails, it is possible to get about ten times the contact surface of a 250,000 cir. mils bond, but as moisture soon creeps in and corrosion takes place, the effective contact surface is soon cut down.

The greatest trouble with all rail bonds is that enough care and attention is not used in their purchase and installation. Copper rail bonds should be flexible enough so that movement of the rail will not damage either the bond or the contact surface between the bond and the rail. An ideal place for installing bonds is underneath the fish-plates, fastening the bond terminal into the web of the rail. In this location the bond can be made very short, usually not over 10 in. The shorter the bond the less the resistance of the track return is increased at the joints. Also in this location the bond is protected from copper thieves. It is usually a good plan to keep the area of the bond as large and its length as short as possible. Another very important thing to look out for is that the fish-plates do not pinch the copper strands of the bond. If these strands are pinched by fish-plates, the expansion and contraction of the rail due to changes in temperature will soon cause some of the strands of the bond to break in two, and the carrying capacity of the bond is by this means considerably lessened. Some roads use two bonds on the same joints in order to insure a path of good conductivity in case of failure of a single bond. Where double bonding is not required to keep the heating of the joints down, this practice is not recommended. One of the two bonds is very likely to have imperfect contact and the road has the service of only single bonding at the expense of double bonding, so that it is better practice to install a single bond of sufficient capacity and to maintain it.

The capacity of a bond will be determined by the heating of the bonds at the contact. For contact surfaces about 100 amperes per square inch is good practice. A 4/0 bond has a contact surface of about 1.5 in., so that about 150 amperes may be allowed for each 4/0 bond. The fish-plate well bolted up will carry about 50 amperes. Hence 400 amperes is a load for two rails bonded with single 4/0 bonds. Of course, such a track will carry considerably more current but there will be heating at the joints and the life of the bond will be very much lessened in the same way that the life of any machine is lessened when it is overloaded. If more current has to be carried, a larger bond should be used. If this is not possible, double bonding will have to be resorted to.

When the bonding supervisor is called upon to order bonds for a piece of new track, he frequently finds that the rails and fish-plates have already been ordered and possibly are on the ground. The fish-plates selected have frequently no provision made for a bond placed underneath them on the web of the rail, so that he is forced in ordering bonds to use bonds of an undesirable type. Fish-plates ordered for an electric railroad should have as large a space as possible between the plates and the web of the rail. Extreme care should be used in selecting bonds to see that the strands of the bonds are not pinched by the fish-plates. For this purpose full information should be given the bond manufacturers of the size of the rail, fish-plate and bolt

* A paper read at the seventh annual convention of the Southwestern Electrical and Gas Association, Houston, Texas.

spaces. This is best furnished by means of blue-prints of the rail sections, and fish-plates used. These blue prints can easily be obtained from the rail joint manufacturers.

Too much care cannot be taken in the way in which bonds are put on. In drilling the holes in the rail, oil under no circumstances should be used, because it is impossible to wipe all of this oil out of the hole, and a thin film will be left in, which will cause a high resistance contact, which in turn will cause heating. In a short time the increase in the resistance of the bond will be so much that electrically the bond is of no use whatsoever. The writer has not found any trouble in having holes bored dry, but if some sort of a lubricant is demanded sal soda and water is recommended. After such use, however, the hole should immediately after it is drilled be very carefully wiped out with a clean rag. Without any delay the bond should be installed so that the contact will not be damaged by rust. Before installing the bonds, the bond contact terminals should be polished with emery cloth. When using a screw compressor a very small amount of flake graphite mixed with oil placed in the punch hole on the bond head will prevent the compressor plunger from cutting the bond and will enable the compressor screw to be turned up much more readily. Care should be used, however, that none of this graphite and oil is gotten on the contact surface. The writer has found that the wrenches furnished by the makers for screw bond compressors do not have enough leverage power. It is his custom when a new screw compressor is received to have the length of the wrench increased to five feet. He also instructs the compressor man by all means, if possible, to break the compressor by turning up on the wrench when compressing bonds in the rails.

Care should be used in sharpening the drill bits used for boring bond holes, as a drill bit not properly ground will drill a hole considerably larger than it is supposed to. For this reason bonds expanded by means of driving a steel pin into the centre of the bond head are, in the writer's judgment, very undesirable. These steel pins do not allow for various sizes of holes drilled with different bits. Men to work on the bonding gangs should be selected with great care. Only such men should be used as are able to realize the importance of bonding and are able to be taught how to install them. They should be conscientious enough to do the best they can whether or not the boss is watching them.

Immediately after a bond is installed and it is covered up by the fish-plate, it is impossible to tell whether or not a first-class or only a fair job has been done. Poor workmanship will show up in six months or a year's time. Bonds which extend around the outside of the fish-plates are undesirable, both on account of their great length and their danger from copper thieves. Soldered, brazed, and welded bonds have been used to a considerable extent, but it is very difficult to get them properly installed with the kind of labor usually available. The electric brazed bond, however, is desirable, but its installation necessitates expensive machinery. Amalgam bonds give good results for temporary bonding, but do not last for any great length of time. Welded joints can only be used in paved streets where the rail is buried. This prevents sudden changes in temperature, and also prevents buckling due to expansion. This type of joint is to be recommended where the full carrying capacity of the rail is required and the tracks are buried in paved streets.

Railroad crossings and all track special work should be bonded by means of copper cable extending around them, unless the crossings and special work are of the solid weld type. The carrying capacity of this cable should be the same as the rail itself, as on a bolted up crossing or special work very little dependence can be placed upon the rails themselves carrying any current. If desired, old rails, well bonded into the tracks on each side of such special work, can be used to good advantage for special bonds. On all track, attention should be paid to having the fish-plate bolts well tightened up, for, if the joints are loose mechanically, the bonds will soon be damaged so that they are of no practical use.

If there is a great deal of current leakage from the rail to the ground, it will be found that the base of the rail will wear out, due to corrosion, much faster than the ball. In fact, if this leakage is too much, the base of the rail will be damaged in a short time so that it cannot be spiked to ties. Salts will increase this corrosive effect. It has been found that ties treated by the chloride of zinc process in order to prevent the ties from decaying, will, when used under rails carrying electric current of 100 to 200 amperes, cause the base of the rail to be eaten away in three years' time, so that the rails are practically useless. This happened under the writer's observation on tracks that were both well and poorly bonded. The poorly bonded track corroded much faster than the well bonded track.

An idea of how much current sometimes leaks from an electric railway track, is given by an observation of the amount of current given up to a power house negative bus by means of a 500,000 cir. mils cable connected to telephone lead sheathed cables about 4,000 feet away from the power house. The output of the station at the time was 1,500 amperes. It was found that 350 amperes of the return was being picked up on the telephone lead sheathed cables buried in an underground conduit, and was returned through the 500,000 cir. mils ground wire, thus amounting to over 20 per cent. of the current return.

In investigating railway circuits, it is well to keep graphical records of the power house output, and also to place graphical recording meters at various places on the system between the rails and water pipes. From these records values can be gotten of the power house output and at exactly the same time the leakage from the rail to the ground can be obtained. All of these values can be placed on a map and different values of the leakage for different outputs of the station and different shiftings of the location of the load on the system can be studied. Thus a good idea of what is necessary to do in order to cut down leakage to a minimum from the track to the ground can be decided upon. At any rate, the track bonding should be kept in first-class condition. For this purpose the bonding should be carefully done in the first place and once a year all rail bonds should be tested by reliable men. All defective bonds should be repaired. It is common practice to compare the resistance of a rail joint with the resistance of a length of the same kind of rail. That is, the resistance of the joint would be said to equal two, three, or four feet of rail, as the case might be. There are various bond testers on the market which will give this reading direct. Most of them rely on the current in the rail itself, or that there is no current flowing to give any tester which will show conclusively whether or not there is any current in the rail. Sometimes it is hard to tell whether the joint in question has as good carrying capacity as the rail itself, or that there is no current flowing to give any readings. Joints on seventy pound rail bonded with 4/0 bonds which show a resistance of five feet of rail, are only fairly good. Those joints which go over ten feet are bad. A 4/0 bond in 70-lb. rail will, if it is in first-class condition, usually show a resistance of from one to two feet of rail.

Before deciding upon the supplementing of track returns by means of auxiliary return feeders, it is well to make some test of the exact resistance of the track return, and of the overhead resistances. This can be done by

means of a water rheostat load placed at night upon the system, after the cars are all in. Ammeter and voltmeter readings should be taken using, perhaps, a telephone line, or, if the system is sectionalized, one of the unused sections, as a voltmeter lead back to the station. The resistance of the overhead and ground return can then be calculated by ohm's law. Assuming that the track bonding is in first-class condition, then, if any more feeder is to be run, this feeder, for the best economy, should be used as a ground return, if the return resistance is the largest; and for a trolley wire feeder if the overhead resistance is the largest. Although in general it is necessary to keep the resistance of the return considerably less than the resistance of the overhead, in order to minimize leakage and keep the return current confined to its legitimate conductors which consist of the rails and ground feeders.

To sum up, it can be stated that satisfactory return circuits are only possible with first-class track bonding. Poor bonding workmen will spoil the best bond ever made. Care should be used in the purchase of track bonds, and the greatest care should be used in their installation. Periodically, thoroughly reliable men should test and repair all bonding.

TRACK FOUNDATIONS UNDER PAVEMENTS.

The selection of the type of track foundation under city streets which will give the best service at a minimum expenditure is a problem which confronts engineers when they prepare for the reconstruction of existing lines or for new extensions. In a recent issue of the Electric Railway Journal this subject was commented upon editorially, and the remarks there made are worth attention. There appears to be a general tendency to use concrete almost exclusively for this purpose. Careful investigations made recently on the surface railways in Chicago, however, have shown that similar results may be obtained by using a compactly-rolled or tamped crushed stone or gravel. A study of the advantages and disadvantages of both types affords a comparison that is instructive.

When concrete is employed as a track foundation the accepted practice has been to make the depth 6 in. under the ties. On new work little difficulty is experienced in obtaining first-class concrete foundations; the track is laid and blocked to a proper elevation, and the concrete foundation deposited in place and allowed to set perfectly before it is necessary to turn traffic over it. In the reconstruction of old track the results are not so satisfactory unless it is possible to route traffic around the piece of newly-laid track; in fact in many cases the foundations are not permitted to set sufficiently before cars are operated.

Investigations as to the proper length of time to allow for the setting of concrete foundations have shown that it should be not less than ten days, and experience on the Chicago railways has extended it to fourteen days. In many cases the failure to allow sufficient time has resulted in crushing the green concrete, causing the track to become badly out of line and surface. It has been learned that the best results are obtained by spacing the ties, whether steel or wood, at 3-ft. centres. The general opinion has been that concrete provided additional bearing. It has been found, however, that dependence upon the concrete bearing value has led to increased tie spacing to such an extent as to break down the foundation.

The use of crushed stone or gravel instead of concrete for foundations offers little advantage from the standpoint of initial cost for new work. However, in the reconstruction of old track, the use of one of these materials may be advantageous for several reasons. Although it may be necessary to increase the depth of the foundation 1 in. or 2 in., the cost of the material in place is lower, and the setting time is eliminated. In fact, the best results are obtained if traffic is turned over the track immediately after it is raised to the finished elevation. This reveals the weak points and permits retamping before the paving is laid.

The fact that ties must be spaced at closer intervals on crushed stone than on a concrete foundation has influenced the popularity of the latter type. The result of the tests on the Chicago railways shows that spacing should be decreased to 2-ft. intervals for either wood or steel ties. The reduced cost of material and labor with crushed stone as compared with concrete, however, more than offsets the increased cost of ties. As to the relative life of the tie in crushed stone or in concrete foundations, experience has shown that there is practically no difference. A factor which does not appear to receive proper weight is the reduced maintenance cost resulting from the use of crushed stone.

While the use of concrete is absolutely necessary in some instances, particularly where the subsoil is composed of quicksand or boggy material, these cases are special. Where the subsoil has good bearing qualities, crushed stone may be used so as to secure increased flexibility and decreased maintenance cost. Another point for consideration is the result of increased rigidity where that exists in track construction. The more rigid construction is believed to increase rail corrugations, and, therefore, to decrease the life of the rail. The cost of rail-grinding is also a factor.

During the reconstruction of old track, the problem of routing cars is a serious one, especially during rush hours, on many railways. As it is essential to a good concrete foundation to keep the track affected out of service for at least ten days, the cost and inconvenience of the delays experienced in routing traffic around new work should be considered.

Since the cost of material and labor in the construction of a concrete foundation is about the same as for crushed stone and the life of both types is about the same, provided equal diligence is employed during the construction period, the matter should be considered from the standpoint of operating cost. The increased facility for making repairs and the probable reduction of rail corrugations, which affect the cost of maintaining the equipment if they are serious, are worthy of thought When the question of foundation is not governed by the bearing quality of the subgrade, it appears that crushed rock or gravel has many advantages under the conditions prevailing in Chicago.

TEST OF MARINE THERMOMETER.

The Minister of Marine will afford Prof. H. T. Barnes, of McGill University an opportunity to make a practical test of his micro-thermometer, the instrument devised by the professor to give warning of the presence of icebergs at sea. A test of the apparatus was made in the Gulf of St. Lawrence by the steamer Stanley in 1910.

The Minister's intention now is to give it a further and more extensive trial. To this end the Government ice-breaking steamer Montcalm will be commissioned to cruise during the month of June next in the waters of Belle Isle and between that point and the entrance of Hudson Straits, equipped with the micro-thermometer. Every precaution will be taken to give the instrument a thorough trial. Should it prove efficacious in indicating, at any considerable distance from the ship, the existence of ice in quantity, doubtless the micro-thermometer will be adopted as a standard adjunct to modern equipment designed to assure the safety of ships at sea.

AN EFFICIENT METHOD OF HANDLING CONCRETE FOR STREET PAVING BASES.

The illustration shows the plan view of an installation used in laying the concrete street bases in Portland, Oregon.

This installation embodied several novel features, and resulted in a great saving, both in time and money, over the ordinary methods of handling concrete in this kind of work. The raw material was piled on a cross street back of the mixer, and a drag bucket was used to haul the sand, gravel, and cement to the mixer.

On the streets where there were no railway tracks, Koppel portable track was laid down the centre of the street, a Y switch leading to the mixer, as shown in the drawing. A turntable was placed at the end of the track, and from the turntable short sections of portable track were laid at right angles to the length of the street, and reached to the curb line.

The mixer unloaded directly into Koppel steel dump cars, and the cars were then run down the track to the right or left, and the concrete deposited just where it was needed, requiring very little shoveling. In this way a section of the street base was laid clear across the street, after which the turntable and cross tracks were moved six or seven feet back toward the mixer by merely removing a section of the portable track.

On the streets where there were double railway tracks two different methods were employed in carrying on the work. In both of these methods the mixer, materials and Y switch were placed as in the method just described.

On some of the streets the portable track was laid the length of the street between the two railway tracks. This method allowed the concrete to be dumped to either side of the portable track, thus filling in the space between the railway tracks. At the end of the portable track a turntable was placed, from which a section of portable track ran to one curb. This left one of the railway tracks clear, while on the other, when a car came along, the cross section of portable track was very easily lifted up and replaced after the car had passed. The turntable and portable track were blocked up just enough to permit the cross track to be laid on top of the street railway rails, so no elevated tracks were required. After the one side of the street and the section between the railway tracks was completed, the portable track was removed to the other side of the street and that part of the street completed. Another method employed on streets with double railway tracks was to lay the portable track on one side of the street and fill in that side of the street and one of the railway tracks. The portable track was then moved to the other side of the street, and that side and the other railway track filled in. This left a space between the two railway tracks to be filled in, which was done by using the turntable and a cross section of portable track which was laying either side of the street.

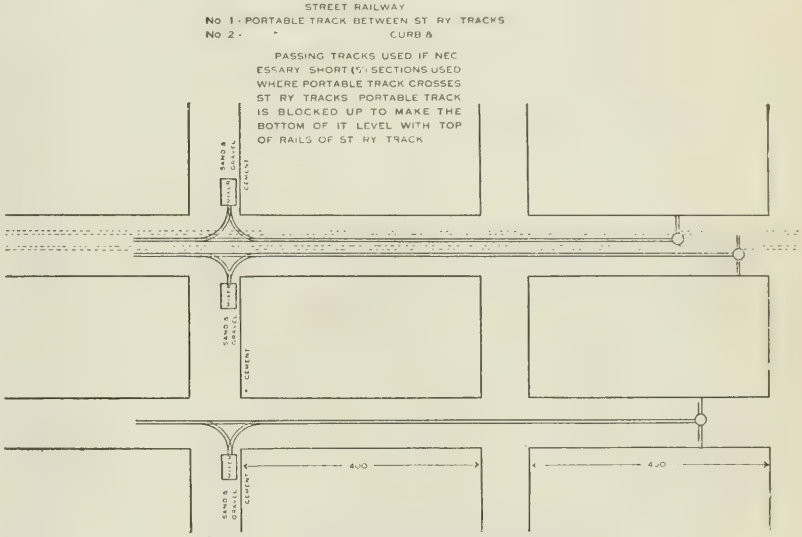
In all three methods employed, the concrete was dumped away from the portable track, and as a section of the base was laid a short section of the portable track was removed and the turntable and cross section of track moved back toward the mixer.

The great advantage of all three methods was that the concrete was placed just where it was needed, and handling the concrete reduced to a minimum.

TESTS OF SHEET PILING.

The last report of the Committee on Wooden Bridges and Trestles, of the American Railway Engineering Association gives some interesting methods for tests on sheet piling.

The procedure suggested for these experiments was that a strong concrete open-top box be made, across the middle of which a vertical plate diaphragm of tempered spring steel could be set; this diaphragm being held in place against horizontal motion at its top and bottom. On both sides of this diaphragm the box would be simultaneously filled with the material to be tested, as sand; thus representing (when the box is full) sheet piling driven in sand.


STREET RAILWAY
No 1 - PORTABLE TRACK BETWEEN ST RY TRACKS
No 2 - " CURB &
PASSING TRACKS USED IF NECESSARY SHORT (5') SECTIONS USED WHERE PORTABLE TRACK CROSSES ST RY TRACKS PORTABLE TRACK IS BLOCKED UP TO MAKE THE BOTTOM OF IT LEVEL WITH TOP OF RAILS OF ST RY TRACK
SAND & GRAVEL
CEMENT
40'
40'

Plan of Layout for Handling Concrete.

The sand was then to be removed from one side of the diaphragm, as would occur when a trench is excavated protected by sheet piling. After the diaphragm had assumed the curve due to the pressure of the sand its curved shape was to be accurately determined and a closely fitting template made to record its curvature.

In order to determine the amount and distribution of the sand pressure, the diaphragm would then be removed from the box and placed horizontally, supported at its ends at the same points it was supported by when vertical in the box. A number of metal strips should be provided, each long enough to reach across the diaphragm, but of varying thickness to make up any required weight, and of equal width.

These would be piled at equal intervals on the diaphragm until it reaches the exact curve of flexure which was given it by the sand and recorded by the template; bearing in mind that the tops of the successive piles of metal strips must be on a curve of some uniformity (which may be called the curve of load) without such irregular outline as that of a battlement, and carried over the supports on the line indicated by the curve approaching them. The total pressure, and the centre of pressure, would thus be determined, it is thought, with considerable accuracy.

As a check, the flexure curve of the diaphragm already found could be plotted to a convenient scale, and successive differentials taken thereof up to and including the fourth. As the equation of this flexure curve is unknown, the differentiation would be done graphically, remembering that the first differentiation gives the curve of tangents to the flexure curve; the second the curve of moments; the third the curve of shear, and the fourth the curve of load, which should

agree with the curve of load determined by the first method —that of weights superimposed on the horizontal plate.

Other materials than sand need testing, such as a heavy semi-fluid mud, and ballast. In each case the angle of repose would be noted of the unretained material, and its weight per cubic foot.

In order to obtain definite conclusions the concrete box and steel diaphragm should be of rather large size; and to prevent the friction of the retained material on the sides of the box from affecting the result materially, narrower steel plates could be placed on each side of the main diaphragm, observations being taken on the main plate only.

The investigation could be extended to determine the pressure on abutments, which are generally filled against gradually on one side only. It seems probable that under such mode of filling, the total pressure would be greater, and its centre lower, than in the case of sheet piling.

THE PEAT PRODUCER GAS POWER PLANT AT THE GOVERNMENT FUEL-TESTING STATION.*

By B. F. Haanel, B.Sc.†

Owing to alterations in the construction of the peat gas producer, now being made by the Körting Brothers, of Hanover, Germany, the tests which have been made and are now under way are not complete. This paper, therefore, can only treat in a general manner of the production of power from peat in so far as it relates to the investigations made at the Fuel Testing Station.

The reasons and necessity for the establishment of a Fuel Testing Station, and the benefits which it is expected will accrue to those provinces which possess no coal deposits and consequently are dependent on foreign sources for their fuel for all purposes, by demonstrating a satisfactory and comparatively cheap method for the production of power from peat, lignite and the cheaper grades of the imported coals, have been many times stated, so that it will be unnecessary to reiterate them here.

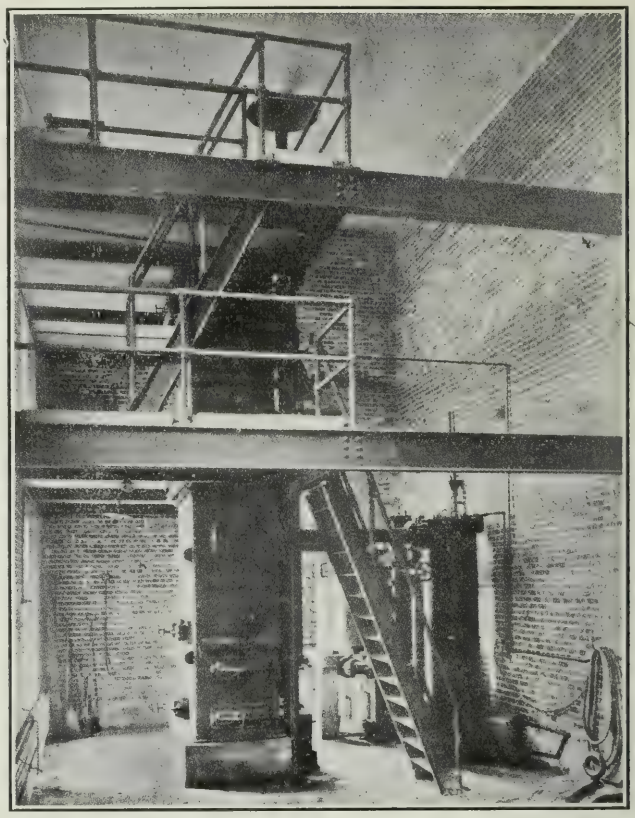
While the Fuel Testing Station was originally erected for the purpose of demonstrating a commercial and economical method of generating power by the utilization of peat in a gas producer, the plant has been enlarged sufficiently to include the investigation of lignite and coal in the producer.

That part of the power plant in which peat is exclusively used consists of a 60 horse power Körting peat gas producer and gas engine with a direct connected 50 kw. direct current generator. The load which it is desired to carry on the engine is regulated by means of a portable resistance stand capable of absorbing the full load of the generator.

The producer gas cleaning apparatus consists of a wet coke scrubber, tar filter and a dry scrubber. The engine is started by means of compressed air, which is supplied by a compressor driven by a 3 h.p.—a.c. motor, which charges into a receiver. A suction fan driven by a 1 h.p.—a.c. motor is provided for starting the producer.

Description of Producer.—The Körting peat gas producer as originally installed, consists of a rectangular steel shell about 15 feet in height from the floor level by about 5 x 3 feet in horizontal section. Near the top, grates are provided on either side. These two entirely independent grates are separated by a space approximately 12 x 12 inches. Below the grates are chambers into which the ashes drop, and these ash chambers and the grates above are accessible through two doors. About 3 feet above the floor level there is a second grate with two ash pits, one on either side, access to which is provided by two doors as above. Directly above the grates near the top or upper zone, a cast iron chamber is provided. This chamber is connected by means of a water jacketed pipe to a similar chamber beneath the grates near the bottom of the producer. This is called the lower zone. These two chambers are provided with doors for the purpose of cleaning. In addition to the doors just described, there are two doors situated on the back of the produced just over the lower zone grate bars through which the fire can be poked or cleaned.

On top of the producer are two hoppers for feeding fuel to the two grates of the upper zone. The doors covering the ash pits of the upper and lower zones are provided



60 Horse Power Körting Peat Gas Producer at Government Fuel Testing Station, Ottawa, Canada.

with adjustable air openings. The lower end of the water jacketed pipe mentioned above, is submerged in a water seal.

The lining of the producer, which is made of the best quality of fire brick, conforms to the general shape of the producer for a distance of about four feet above the grate bars of the lower zone. From this point, the lining is jogged or stepped on the two narrow sides until the grate bars of the upper zone are reached, leaving a space of about 12 x 12 inches.

Principle of Operation.—The green peat containing about 30 per cent. moisture and a large amount of volatile matter, is fed through the two hoppers described above, and is partially burned on the grates of the upper zone. The heat resulting from the combustion of peat is, or should be, just sufficient to drive off the moisture and volatile matter, leaving behind practically pure peat coke, which falls through the narrow opening below the upper grates into the

* From the Journal of the Canadian Peat Society.

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lower zone where the final and complete combustion takes place.

In addition to the moisture and heavy hydrocarbon vapors driven off from the peat during the process of coking, the gases passing into the lower zone contain nitrogen, a small amount of carbon monoxide, carbon dioxide, and a trace of methane and ethylene.

When the producer is in condition for operation, the space between the grates of the lower and upper zones is filled with peat coke, the lower layer of which, for a height of about eighteen inches above the lower grates, is incandescent owing to the combustion of the coke on these grates.

The gases, heavy hydrocarbon vapors and moisture evolved from the combustion of peat in the upper zone, are drawn up (by means of the suction of the fan or engine) into the gas chamber above the grates of the upper zone, previously described, into and down through the water cooled pipe into the chamber beneath the grates of the lower zone and then up through the bed of incandescent peat coke to the two off takes on either side of the producer to the cleaning system and engine.

A small quantity of the heavy hydrocarbon vapors and possibly some of the moisture is condensed on the walls of the water cooled pipe and drops into the water seal below, where the resulting tar can readily be removed.

The gases of the upper zone and the remainder of the hydrogen vapors and moisture now pass through the incandescent coke of the lower zone. Here the hydrocarbon vapors admitted into the lower zone together with the moisture (steam) and air admitted through the air openings in the ash pit doors, in passing through the hot carbon either burn, or are split up into permanent combustible gases. The moisture is reacted upon by the hot carbon. The result of this reaction is free hydrogen and either carbon monoxide or carbon dioxide. The carbon dioxide, evolved in the upper zone, is reduced to carbon monoxide. The final gas consists of a large quantity (by volume) of nitrogen, carbon monoxide and smaller quantities of carbon dioxide, hydrogen, methane and ethylene.

The Cleaning System.—As previously mentioned, the cleaning system consists of a wet coke scrubber, tar filter and dry scrubber.

The wet coke scrubber consists of a cylindrical, steel shell about 6 feet in height by 2½ feet in diameter, closed at the top by an air tight cover and at the bottom by a water seal. This shell is filled for a height of about 3 feet with coke. When in operation, this coke is continuously sprayed with cold water. The final gas leaving the producer enters the scrubber near the bottom and leaves near the top. In passing up through the wet coke and water spray, the gas is cooled and most of the dust and a large quantity of tarry matter, which escaped decomposition in the producer, is removed.

From the wet coke scrubber, the gas passes through the tar filter. This filter consists of a cast iron box about 3 feet in height, and 3 feet by 6 inches in horizontal section. Inside this box are fixed a number of baffle plates and four perforated metal plates which are placed near the outlet. These plates can be sprayed with hot water when the suction on the system indicates that the filter is clogged. The gas enters at one end of the filter and passes in and out among the baffle plates and through the perforated metal plates and then into the dry scrubber. Most of the tarry matter carried with the gas past the coke scrubber is removed in this filter and flows off with the wash water into the seal. The dry scrubber is a cylindrical steel shell about 4 feet in diameter by about 3 feet in height, closed on the top and bottom. The top cover can be removed. This shell is packed with excelsior through which the gas must pass before entering the engine. Free moisture and some tarry matter is removed from the gas in its passage through the scrubber.

Results of Tests.—Several tests have been made with the peat manufactured at the Victoria Road peat bog, and with that manufactured at the Government peat plant at Alfred.

In these tests, peat with varying quantities of moisture were used, the lowest quantity being 15 per cent. and the highest 43 per cent. Since the producer is designed to operate with peat containing from 25 to 30 per cent. water and is, therefore, not provided with an evaporator for supplying steam (which is absolutely necessary when running on dry fuels), 15 per cent. moisture peat was found to be too low for satisfactory operation owing to the high temperature prevailing in the producer and of the final gas,—thus lowering the thermal efficiency,—and the formation of some tar.

While peat containing moisture up to about 40 per cent. can be used by operating the plant at half load, the most satisfactory moisture content was found to be about 25 to 30 per cent.

Any tar which may be formed and find its way past the cleaning system into the admission valve and cylinder of the engine can be easily removed while the engine is running, by injecting into the open end of the cylinder a mixture of oilsoap and water. Tar resulting from the distillation of peat is readily soluble in such a mixture and in this respect differs from coal tar.

Fuel Consumption.—The average fuel consumption per b.h.p.h. at full load (60 h.p.) was found from many tests to be from 2¼ to 2½ lbs.

For one bare horse power year of 3,000 (300 ten-hour days), this would amount to 3.75 tons.

For the purpose of showing the saving in fuel costs, which can be realized by generating power from peat in the peat producer gas plant, the following comparisons are given.

In estimating the following costs, the cost of one ton (2,000 lbs.) of machined peat, at the bog where the producer-gas plant is assumed to be situated, is taken at $2.00. The cost of a ton of soft coal is assumed to be $4.00 in carload lots, f.o.b. At some points this price would be less, while at others it would be considerably higher.

The consumption of peat per brake horse power hour is assumed to be 2½ lbs.; lower fuel consumptions have been obtained, but the writer desires to use a conservative figure.

The fuel consumption per brake horse power hour of the coal producer gas plant is taken at 1½ lbs., and that of the steam plant at 6 lbs. The latter figure relates only to comparatively small plants.

On this basis, the fuel costs per brake horse power year (3,000 hours) would be as follows:—

	Fuel, cost per brake horse power. Year.
Peat producer gas plant, peat at $2 per ton	$ 7.50
Coal producer gas plant, coal at $4 per ton	9.00
Steam plant, coal at $4 per ton.....	36.00

When peat is manufactured on a larger scale with machines provided with mechanical excavators and other labor saving devices, the above cost (2.00) per ton will be very greatly reduced, so that a power plant situated at the bog will be able to show a much greater saving in fuel costs over that of a coal producer gas plant or steam plant.

In order to arrive at the saving, which will be effected by the utilization of either peat or coal in a producer gas power plant over that of a steam power plant, it is necessary to estimate the operating costs and fixed charges since these will remain about the same for all the plants in question. A slight saving will, however, be realized in the peat

producer gas plant, over the steam and even the bituminous coal producer gas plant, in the operating costs, since the peat producer gas plant is very easily handled, the producer practically taking care of itself. Hence, one man, an engineer at moderate wages, can easily take care of a 100 h.p. plant. While this is true in a general sense, the writer has seen a 150 h.p. bituminous coal producer plant handled entirely by one man, but such cases are not common. A bituminous coal producer is more difficult to operate and requires more or less constant attention, and therefore for proper working should have the services of a stoker. A steam plant of like capacity would require a fireman in addition to the engineer. In short, a peat producer gas power plant, in its simplicity and ease of operation, is not unlike an anthracite producer gas plant, which is recognized as the simplest of all such plants.

While hydro-electric energy is in many sections of those provinces possessing water powers, the cheapest power available, and for many purposes the most suitable, it must be borne in mind that there is a limit to which electric energy can be economically transmitted, since the cost of power increases rapidly with the length of the transmission line. In addition, there are localities which cannot be served by such transmission lines and still others to which such power is not suitable—for example, those requiring a 10-hour or intermittent service. For such districts, it is manifestly cheaper and more satisfactory to develop power independently by some other means, and it is hoped that producer gas power plants erected on a few wisely chosen bogs will serve this purpose.

The demonstration plant at Alfred and the Peat Producer Gas Power Plant erected in the Fuel Testing Station at Ottawa (the former serving to demonstrate a commercial process for the manufacture of a cheap fuel from peat and the latter serving to demonstrate an entirely commercial, economical and reliable method of generating power from such fuel), will, it is hoped, prove instrumental in:—

1. The development of such of the peat bogs found in the the provinces of Ontario and Quebec, as are suitable for the manufacture of peat fuel, along sane and commercially profitable lines.

2. The establishment of power plants on the bogs, which will serve existing towns and cities with electric light and power, and attract industries to those parts of the above provinces which can be economically and satisfactorily served by such power.

CONCRETE TELEGRAPH POLES ACROSS MARSHY GROUND.*

By GEORGE GIBBS.†

Among the facilities required on the New York Terminal Division of the Pennsylvania Railroad was the Railroad Company's telephone service. The line for this purpose forms an extension of the New York-Philadelphia main line, from its point of intersection with the Terminal Division at the east side of the Passaic River near Newark, N.J., and consists of a pole line along the right of way across a continuous five-mile stretch of semi-tidal meadow swamp land known as the "Hackensack Meadows," to the tunnel portal at Bergen Hill, the Hackensack River being crossed midway of the section. The ground surface is covered with a heavy growth of reeds, and the top stratum is a peaty bog, from 8 to 15 feet deep, underlaid with varying strata of clay, fine sand, and mixed sand and clay for very considerable depths. It will be seen, therefore, that the problem was to provide a design of pole which would not only be strong in itself, but which could be set in a stable foundation in a soft and uncertain ground. It was desired to make the line entirely secure against interruption by severe storms or by fires in the swamp reeds. It appeared, under these conditions, that the ordinary type of wooden pole would not be wholly satisfactory, either as regards strength for such a heavy service or safety as regards the frequent meadow fires.

The use of reinforced concrete poles for the purpose appealed to us, but very little reliable data about either the cost or service from such design was obtainable. In Europe the author had observed the quite extensive use of concrete poles, chiefly for electric transmission purposes, but details of their construction were not at hand. These poles are frequently of structural steel covered with a protective coating of concrete, and sometimes are of wood encased in concrete, and much ingenuity has been expended in devising special forms of composite poles, but with what practical success it is difficult yet to say.

Manufacture of Concrete Telegraph Poles, Showing Skeleton Frame Suspended in Place; Frame in Form, Ready for Pouring, and Finished Pole.

The desirability, however, of securing a strong fireproof line across this section of our road was so great that the writer undertook to design in his office a simple form of reinforced concrete pole, which could be manufactured on or near the work and at a cost which would not be prohibitive. Without previous data to go upon the design evolved is somewhat experimental, and probably the notes here given will not be of very great assistance in fixing a precedent for an ordinary telegraph pole, as our conditions called for heavier construction than usually required of such lines. The data, however, is given for what it is worth, as indicating a heavy and difficult piece of construction for a special problem.

There were 202 poles required, spaced from 70 to 135 feet apart, with an average standard spacing of 120 feet, the variations in span being due to numerous railway and highway crossings. The height of the top of poles above the ground also varies for the local conditions from 25 to 50 feet, and the total length of poles from 35 to 65 feet. The loading called for an ultimate capacity of 60 open tele-

* A paper before the Eighth Convention of the National Association of Cement Users.

† Consulting Engineer, Pennsylvania Railroad.

graph wires and two 40-pair telephone cables and one signal control cable. The open wires are of copper, Nos. 7 and 8 B. & S. gauge, and the cables Nos. 13 and 16 B. & S. gauge insulated wire, with a lead covering. The cables are carried by steel messenger wires. The weight of the wires and cables is 10½ pounds per running foot, giving a total loading for the average span of 1,268 pounds per pole, or including cross arms, insulators, brackets and fittings, 1,500 pounds per pole. In addition to this static vertical loading, emergency conditions were assumed of an extra loading of half inch of ice on the wires and a wind pressure of 8 pounds per square foot on wires and 13 pounds per square foot on poles. The stresses under these conditions not to exceed the elastic limits of the wires and of the carrying structures. These assumptions are equivalent to a vertical loading of 7,600 pounds per pole and a horizontal

Concrete Telegraph Pole Line over Hackensack Meadows, N.J.

force of 4,000 pounds exerted one foot below the pole top. The normal sag of the wires at 60 degrees Fahrenheit temperature is 4½ inches and a normal tension of 273 pounds for No. 8 wires and 130 pounds for No. 9. The maximum hot sag at 130 degrees Fahrenheit is 11 inches; the tension in the wires under maximum wind pressure with the ice loading at 20 degrees Fahrenheit is 702 pounds and 470 pounds respectively for the two sizes of wires.

The design adopted is that of a tapering, smooth surface, reinforced concrete pole, square in cross section with chamfered corners and having a taper of ½ inch in 5 feet. The concrete is of 1½:2:4 mixture, assumed to have an ultimate strength in compression of 2,000 pounds per square inch. The reinforcement is composed of mechanical bond bars tied together into a square skeleton frame, and in the complete pole this reinforcement is covered by a one-inch minimum thickness of concrete. The following table gives details of the complete construction.

In order to manufacture the poles economically a yard was established adjacent to the right of way and with side track connections for delivery of materials. The ground was leveled and set with stringer pieces, three feet apart, of old wooden car sills, so as to furnish a convenient surface upon which to erect the timber forms. This yard permitted of the simultaneous manufacture of six poles and the storing in place of 90 poles during the period of seasoning. In the process of manufacture the skeleton reinforcement is first made up, the twisted steel mechanical bond bars being tied together to form a square skeleton frame; this frame is then suspended at the proper height above the ground and the sectional wooden frames put in position around it. The concrete mixture is then poured in and carefully tamped. In this way six poles were made per day and were left in place at least sixteen days to season.

Table of Concrete Poels.

Length, feet	Equivalent pull, 1 ft. from top.	Edge distance for steel.	Area steel.	Extreme Fiber stress in concrete compression.	Unit compression stress in steel.	Weight of pole.	Cubic ft. concrete	Weight of steel, pounds.	Lin. ft. of wire wrapped around pole.
30	4066	1.75	3.38	1953	19059	5000	33.15	819	228
35	4321	1.75	3.63	2087	20480	6200	41.44	1077	273
40	4505	1.75	4.03	1917	19667	7600	50.75	1309	333
45	4647	1.75	4.40	1987	20428	9200	61.58	1493	375
50	4763	1.87	4.73	1886	19692	11000	73.24	1792	431
55	4860	1.87	5.00	1832	19155	13000	86.58	1974	490
60	4945	2.00	5.30	1812	19083	15000	101.28	2249	533
65	5020	2.00	5.48	1976	18591	17600	117.23	2575	618

After a number of experiments it was found best to set the poles in pits excavated in the marshy stratum. These pits were generally about 9 feet square and 5 feet deep, and a timber grillage was placed around the base of each pole, and about 5 feet below the top of the ground. This grillage consisted of six track cross ties bolted together and to the pole, and partly planked over by 3-inch rough lumber. The pole, which projected below the grillage and was pointed at the butt, was jetted down by compressed air into the sandy layer, so that the grillage would rest at the bottom of the pit. The pits were then back-filled with rock and clay. Poles on curves are cross-guyed, and the terminal and railway crossing poles are head-guyed with steel cables.

In order to determine the stability of the foundations, as above described, as well as the transverse strength of the pole itself, a test was made of a 55-foot pole set in a 13-foot deep foundation. The test consisted in applying a horizontal pull 39.5 feet from the ground. The breaking load was 4,360 pounds and the point of fracture 20 feet from the ground, at the top of the 32-foot reinforcement bars. The foundation itself was found to be amply secure.

The actual cost of labor and material for manufacture of these poles, reduced to a unit cost for an average length pole of 40 feet, weighing 7,600 pounds, was as follows:

Forms—labor and material	$19.00
Concrete—labor and material	26.50
Reinforcement—labor and material	32.00
Total per pole	$77.50

The above does not include cost of preparing site, engineering, etc., and is for the bare poles (without fittings or foundation timbers). To obtain the cost of the poles erected, there must be added the cost of loading, distribution, foundations and setting, cross arms and fittings, but these items were special to the particular location and would be of little use as a matter of general information. It might be stated, however, that the cost of handling and erecting these heavy poles was considerably more than would be the case for wooden poles; furthermore, care must be taken in loading and unloading them and special appliances are required for their erection.

In the special case in question it was figured that the cost of the line erected complete was not greatly in excess of that of an equally stable wooden pole line, as in order to meet such a condition it would have been necessary to employ "H" frame poles and set them in equally expensive foundation pits. In the case of this line it is interesting to note that the foundations and setting cost considerably more than the poles themselves.

To sum up, it may be said that for the particular case of this heavy line having very difficult foundation conditions, the use of a reinforced concrete pole resulted in a durable, safe and neat appearing construction at little additional cost to that of a wooden pole line inferior in all these respects.

Properties of Metals.

THE EDITOR:

Dear Sir,—I enclose herewith a table which I think should prove of interest to most of your readers as it contains information culled from a great many sources, and should prove a good labor saver in hunting up references, etc. F. TISSINGTON, SHERBROOKE, QUE.

METAL	Weight in Lbs.		Cubic Measure		Specific Gravity Water=1	Ultimate Strength			Coefficient of Elasticity Direct	Melting Point		Coefficient of Linear Expansion	Specific Heat Water 32°=1	Atomic Weight	Heat Conductivity Silver =1000	Electrical Conductivity Silver at 32° F. 100		Contraction parts of an inch Fluid to solid state
	Cubic Ft.	Cubic In.	Ft. per ton 2,000 lbs.	Ins. per lb.		Tensile Lbs.	Compression Lbs.	Shear Lbs.		Cent.	Far.					32° F.	212° F.	
Aluminum, Cast	160	.092	12.5	10.9	2.56	13500				753	1392	F. .000013	.212	27 0	665	63.09		
" Wrought	168	.097	11.9	10.25	2.57	33000				630	1157	C. .0000206	.225	27.0	665			
Antimony	418	.242	4.78	4.15	6.72	1100				425	797	F. .0000061 C. .0000108	.051	120.0	215	3.88		
Arsenic	362	.21	5.55	4.76	5.84					412	773.5		.083	75.0				
Bismuth	617	.353	3.25	2.83	9.90	3250				270	518	F. .0000077	.031	208.5				.156
Brass	515	.298	3.88	3.35	8.2	27500			14,230,000	900	1650	F. .00001052	.094			21.0		
" Cast	524	.30	3.81	3.33	8.4	22500	10000		9,170,000	900	1650	F. .0000194	.094					.210
" Wire	533	.309	3.74	3.24	8.548	50000				900	1650	F. .00001074	.094					
Bronze	545	.315	3.67	3.18	8.78											30.0		
Cadmium	542	.314	3.68	3.19	8.74					320	608		.0567	112.0		24.579	17.596	
Chromium	376	.218	5.31	4.57	6.06								.100	52.4				
Cobalt	532	.309	3.75	3.24	8.55								.1073	59.0				
Copper	552	.3192	3.62	3.13	8.9	30000			15,000,000	1054	1929	F. .00000944	.092	63.5	845	91.517	64.919	
" Cast	527	.304	3.81	3.28	8.607	20000	58000		12,000,000	1050	1922	C. .00001718	.092	63.5				.193
Gun Metal 10 Copper 1 Tin	528	.306	3.81	3.148	8.46	36000			13,500,000			F. .00001062						
Gold	1200	.695	1.67	1.44	19.24	20000				1250	2282	F. .0000083	.032	196.5	981	64.96	48.49	
Iridium	1166	.678	1.72	1.48	18.75								.1886					
Iron, Cast	450	.26	4.45	3.8	7.23	17000	95000	10500	17,000,000	1050—1200	1922—2192	F. .000006 C. .000011094	.130		359			.125
" Wrot	480	.28	4.17	3.6	7.698	50000	50000	40000	29,000,000	1500—1600	2732—2912	F. .00000642 C. .000011204	.114	56.0	436	12.350	8.377	.137
Lead	712	.4121	2.81	2.437	11.418	2500	7000		2,000,500	330	626	F. .000016	.031	207 0	287	8.277	5.761	.319
Magnesium	109	.063	18.35	15.9	1.75					230	447		.2499	24.0				
Manganese	499	.289	4.0	3.46	8.0								.122	55.0				
Mercury	849	.491	2.36	2.04	13.596					—38.8	—40	F. .0000333	.033	200.0	677	1.738	1.575	
Nickel	516	.298	3.88	3.35	8.28					1500—1600	2732—2912	F. .0000067	.109	59.0		7.89		
Platinum	1342	.778	1.49	1.29	21.5	53000				1710	3110	F. .000005	.032	195.0	380	7.933	6.688	
Silver	653	.379	3.06	2.63	10.505	41000				1000	1832	F. .000011 C. .0000217	.056	108.0	1000	100	71.316	
Steel, Mild	490	.29	4.08	3.53	7.85	67500	67500	56000	30,000,000	1300—1400	2372—2552	F. .0000066 C. .000010788	.116		397			.133
Tin	462	.267	4.34	3.75	7.4	4700			3,500,000	235	455	F. .00001166 C. .0000217	.056	118.5	422	14.014	8.657	.278
" Cast	455	.262	4.4	3.82	7.291	4480				228	442	F. .00001210	.0548	118.5	422			
Uranium	1146	.665	1.74	1.51	18.5								.028	240.0				
Zinc	428	.248	4.66	4.02	6.86	15800			13,400,000	412	774	F. .0000163	.095	65.4	641	24.063	17.506	.329

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THE CITY AND SUBURBS PLANS ACT.

A step in the right direction has been made by the Ontario Legislature by the passage of the City and Suburbs Plans Act. The clauses of the Act provide that in all cities of a population of 50,000 or over, and throughout a five-mile zone surrounding such cities, the subdividing of areas into building lots, and the locating of highways through such areas must hereafter be in accordance with plans approved by the Ontario Railway and Municipal Board. A copy of this Act appears in this issue of *The Canadian Engineer.*

The growth of towns and cities in Ontario and throughout Canada has been so rapid and the method of laying out building lots in territory adjacent to these cities has been so haphazard that the results to the cities have been rather serious. No definite plan has been adhered to in these sub-divisions, and this has caused great difficulties in providing thoroughfares and transportation facilities when these new areas are annexed to the municipality. Additions to the city's territory have caused increased demand for better transportation facilities, but the lack of connecting streets and main thoroughfares in the new sections has led to endless trouble. The Act as now passed gives assurance that the streets and the general layout in areas hereafter sub-divided will be in accordance with the highways and thoroughfares of the city.

As we have noted, the Act is a step in the right direction. There is still room, however, for legislation giving some oversight or control to the city over a suburb's development. Public improvements, such as waterworks, sewerage systems, street car lines, etc., should be designed so that when they are later connected to the city system there may be a minimum of loss and a maximum of economy.

THE SALARIES OF ENGINEERS.

We have referred many times in these columns to the poor salaries paid by municipalities to their engineers, and, while conditions are improving slowly, there remain many grounds for complaint still. The city of Toronto is by no means the least offender in the matter of inadequate salaries to their engineering staff. Yet, the city, through its City Council, newspapers, and even the engineers themselves, refer to the fact that many engineers have left the city's employ to take positions in other cities at greatly increased salaries. The statement is made, and often reiterated, that Toronto is a training-ground for engineers for other cities. If this is true, and we do not doubt it, the condition of affairs is one to be ashamed of rather than one to express pride in. Heads of engineering departments in Toronto are receiving salaries lower than towns of 6,000 or 8,000 people are paying to their engineers. Assistant heads of departments, men in actual charge of the construction work, are receiving salaries less than the foremen, who are receiving orders from them. Is it any wonder these men leave when the opportunity arrives? Any citizen who makes a statement that the city's engineering department is a training-ground for better positions has little idea of the fitness of things. No worse charge could

be made against the city. If the salary question at the City Hall were adjusted, more efficient work would be done and a permanent staff would be built up. When we consider that assistant heads of departments are receiving salaries of less than $100 a month, and that clerks with no special training or ability are receiving $150 to $200 a month, we can readily understand why so many changes occur in the engineering department.

The City Engineer has not been altogether lacking in blame for this condition, for recently, when the head of one of his departments was appointed to another position, the Council wished to raise his salary and keep him. The City Engineer, however, said that if this man's salary were raised sufficiently to keep him employed by the city, that a number of other increases would have to be made; therefore, he would advise that the salary remain as before. To secure a well-balanced, efficient and enthusiastic organization, each individual man must be satisfied. Therefore, any reorganization of the Works Department of the city of Toronto must include a readjustment of salaries and the payment of sufficient to assure the permanent retention of men experienced in the city's work.

RAIL SPECIFICATIONS.

The standardization of rail manufacture has progressed rapidly during the past ten years, due mainly to the joint action and co-operation of manufacturers and engineers. In a recent issue of a contemporary, Mr. W. C. Cushing draws attention to the test conditions as imposed by the various engineering associations, and it is to these test conditions that a good deal of the advance in the perfection of rail-making is due. It must be added, however, that the frequent failures of rails noted, with the attendant terrible consequences, leaves much to be accomplished still. Mr. Cushing states that specifications for steel rails have always consisted of three general parts: chemical requirements of properties, physical requirements, and the details of manufacture. Up to the time the Rail Committee of the American Railway Engineering Association recommended certain specifications in 1901, the various railways emphasized one or more of the above three parts, according to their individual preference or experience. Some almost ignored the chemical requirements, others were more or less elaborate in their physical requirements, while some barely touched upon the details of manufacture, and others treated the subject quite elaborately. Since that time, by the devotion of considerable time and much careful study to the question, the American Railway Engineering Association have progressed towards the adoption of standard specifications for rails. It has now a set of proposed specifications which embody the best knowledge of the subject, and these are being changed from time to time in the light of new experimental investigation. New methods of testing or improvements on these methods are used to determine the physical property, while practically no change has been made in the chemical requirements from the standard specifications of the rail manufacturers. The railway engineers prefer to subject the finished material to such tests as will cast aside the defective rails, and this accounts for the additional tests over those in use some years ago. A marked improvement is apparent in the rails being laid since the adoption by the manufacturers of the new specification.

EDITORIAL COMMENT.

Now that the first wave of sympathy and criticism regarding the disaster to the Atlantic liner, Titanic, has passed, we are able to form some judgment and to hear the candid opinions of men qualified to speak on the subject. There is little doubt that the sinking of the vessel will have the effect of placing some restraint on the size of future ships. When the region of extreme sizes in engineering structures is reached, experience and precedent alike are at fault. There was a good reason for the project of building the Quebec bridge, but there appears to be little reason for the construction of 50,000-ton liners. The disadvantages of such large vessels are becoming apparent, but until a general public feeling is expressed against their construction, they will continue to be built.

* * * *

The utilization of the peat resources of Canada is becoming an important matter as the cost of coal increases and the liabilities of coal strikes remain. We noted some time ago the foundation of a Canadian Peat Society. The objects of the Society, formed about two years ago, are to gather and disseminate information concerning peat and peat deposits and products, for the purpose of educating the public as to the value of these products, to encourage the drainage and development of bog and peat land for agricultural purposes, and generally to adopt such measures as may aid in the establishment and the sound basis of a peat industry in Canada. With the above objects in view, the Society are now issuing a quarterly journal, which is to be a source of accurate information and of encouragement and aid to peat men in general. This Society is deserving of the hearty support of every Canadian interested in the development of our latent resources.

* * * *

Denver, Colorado, has made a move towards lessening the smoke nuisance. A smoke abatement commission of five members to advise the mayor and the smoke inspector is provided for in a bill drawn up by the city art commission. The bill is more drastic in its conditions than previous smoke ordinances. The following clauses may be referred to: for every alteration made in the chimney of any kind a permit is required; before a heat or an electric generating plant of any kind is constructed, repaired or altered in any manner, the plans and specifications must be submitted to the smoke inspector; persons failing to take out permits to construct or repair furnaces, etc., will be fined $25 for each day of the construction or alteration; persons who cause dense smoke to rise from heating plants, locomotives, etc., are liable to a fine of from $10 to $100 for each offence. While the above conditions are rather rigid, if conditions in Denver are as bad as in some of our Canadian cities, it is quite certain that a severe regulation, strictly enforced, is required. It is time that adequate inspection and enforcement of smoke by-laws and regulations were made.

COST OF TRACK-LAYING ON THE ERIE RAILROAD.

An article by H. C. Landon, Division Engineer of the Erie R.R., in the Erie Railroad Employees' Magazine, gives some figures of cost on track laying under the old methods, which may be of use in determining whether or not the use of a track-laying machine will be economical. Mr. Landon writes as follows: In 1905 and 1906, while Engineer M. of Way of the Buffalo & Susquehanna R.R., I was in direct charge of all track laying, ballasting, etc., between Wellsville and Buffalo, and had, in fact, previous to this time, charge of all the track laying of the Buffalo & Susquehanna system from 1898, about 110 miles in all. I have not the data of cost of this work, except that with the low price of labor, the cost per mile, including rental of engines, cars, etc., and the cost of labor, it did not exceed $275 per mile. As much as 5,700 ft. of track had been laid in a single day with about 65 men, through the winding valleys of the branches of the Susquehanna River, south of Wharton, Pa., and the average kept up to very close to a mile per day, where any considerable grade was ready ahead of the track layers-

On the line between Wellsville and Buffalo there were a large number of bridges to be constructed, as the track laying advanced, the steel for the bridges being brought over the new line, so that the track layers hardly became organized for rapid work before they were stopped for a period of two or three days to two months, while the new structures were being erected. During this period the track layers were ballasting the new track, or engaged in completing unfinished track on troublesome fills. The laborers, especially the spikers and members of the iron gang, had had previous experience, and had in general become quite expert in the work.

About one-third of the men were Hungarians and the balance Italians. No natives were employed. While at first the Slavs were decidedly the better laborers, some of the Italians became expert in spiking and in handling the rail, so that spike gangs and iron gangs were made up of Italians and Hungarians, creating a rivalry which expedited the work considerably.

Two truck gangs were always employed, passing each other by using a portable turntable, or by lifting the heavy truck body from the wheels. Good camp cars were provided, and also a well-equipped blacksmith's shop. A combined gasoline engine and pump, and a tank of 10,000 gals. capacity—which could be quickly taken down and erected—formed part of the equipment, so that the track-laying engine could be kept close to the work.

The longest stretch of grade which was ready for the track and where no large bridges intervened to delay the work, was between Belvidere and Belfast and White Creek bridge. On this stretch it was demonstrated what a track-laying gang could do when the organization was well in hand. This work does not compare with feats in the west over a level country, but among the winding roads of the east, it does compare very favorably. The biggest day's work on this stretch was 5,000 ft. and the average for the 6 miles was 4,600 ft. per day.

North of White Creek bridge, 5,900 ft. was laid on July 2, 1905, including delay of several hours placing a small bridge at Transit Bridge. The average for this one gang during the time employed was about 4,400 feet per day.

Other smaller gangs were employed out of Arcade and Hamburg, working north and south to reach important large structures nearby, and while these did not accomplish as much in a single day, the average of about 50 ft. per man was accomplished.

The track-laying gang was made up about as follows:—

1 foreman, at $4	$ 4.00
2 assistant foremen, at $3	6.00
12 spikers and nippers, at $1.50	18.00
36 trackmen, at $1.50	54.00
2 tie tiers, at $1.50	3.00
2 tie spacers, at $1.50	3.00
1 spike puller, at $1.50	1.50
4 bolters, at $1.50	6.00
2 rail unloaders, at $1.50	3.00
4 tie unloaders, at $1.50	6.00
1 water boy, at $1.25	1.25
Total	$105.75

Behind the supply train, full tie-ing:

1 foreman, at $3	$ 3.00
24 laborers, at $1.50	36.00
1 timekeeper, at $2	2.00
Total	$ 41.00

At storage yard, loading rail and ties:

1 foreman, at $3	$ 3.00
24 laborers, at $1.50	36.00
Engine and crew, at $40 per day	40.00
Total	$ 79.00
Total in all	$225.75

The average amount of track laid per day was over 4,000 ft. At 4,000 ft. per day the cost per mile would be $297.97. As much material, rail, ties etc., was received while track laying was in progress, the expense of rehandling in the supply yard was avoided.

The auditor's books, when rail laying was completed between Wellsville and Buffalo, indicated the entire cost of labor for laying 98.1 miles of track to be $29,515.45, or $300.85 per mile. Of this 98.1 miles of track, 85 miles was main track and the balance sidings, "wye" tracks, and passing tracks.

The labor cost included the building of the turnouts, etc. This is the total cost of labor, including engine and train crew, fuel, supplies and rental of engine and of office force.

All rail laid was 80-lb. A. S. C. E. section.

RAILWAY PLANS PREPARED.

The Canadian Pacific Railway will expend a large amount of money at St. John this year. Mr. D. McNicoll, general manager was in the city recently and stated that plans were prepared for an additional elevator with a capacity of 2,000,000 bushels, and that as fast as the federal government constructed the sea wall, upon which work will be begun this spring, the company would fill in the shore lots at West St. John and lay additional tracks. He said that the company could handle twice as much traffic at St. John as it is doing at the present time if the terminal facilities at the port were able to take care of it. The company during the winter built extensive freight sheds on property that it acquired at the head of the harbor. Mr. McNicoll says much more must be done at that point in order to handle their local and provincial business. The company will spend considerable money during the summer on their railway lines in New Brunswick.

PROGRESS IN CANADA IN BIOLOGICAL METHODS OF SEWAGE DISPOSAL DURING THE LAST TWENTY YEARS.

By Willis Chipman, C.E.

Twenty years ago the principles underlying the biological methods of sewage treatment were attracting the attention of municipal engineers in Great Britain, experiments were being carried on, and phophecies being made, echoes of which were to be heard in Canada.

Broad irrigation was then the accepted standard in Great Britain, although the nitrification theory of purification was not so well understood as to-day. Profitable crops were too often the desideratum rather than sewage purification, but on the whole the results were satisfactory. Broad irrigation had also been adopted at Paris, France; Berlin, Germany, and many other cities. The land necessary for broad irrigation was not always available, however, and many cities and towns in Great Britain and in Germany had adopted chemical precipitation methods, but, generally speaking, its advocates were experimenting continually.

The failure to produce a marketable fertilizer from sewage sludge by chemical precipitants stimulated inventors, and many processes were invented, patented, and advertised to the public.

About 1871 filtration through charcoal was tried in England, as a result of which the conversion of the ammonia and the nitrogen or organic matter into nitric acid was recognized, and the theory of intermittent filtration first brought to the attention of engineers.

The State Board of Health of Massachusetts undertook a series of experiments in sewage filtration in 1886, as a result of which intermittent downward filtration was adopted by many towns, and by 1891 this method of sewage purification may be said to have become the standard in New England.

In the Province of Ontario the first practical attempts at sewage purification were made at the Asylum for the Insane, London. The works were designed by the late Col. George E. Waring, of New York, an engineer of international reputation, and constructed by the Provincial Department of Public Works. The sewage was intermittently applied to channels or ditches, well underdrained, but it was then called a flat-bed-irrigation system. The agency of bacteria was, however, recognized in descriptions given of the system.

These works have been in continuous operation since 1888, and the results have been eminently satisfactory, due largely to the labor available for properly operating the beds, and for cultivating the crops.

In 1890 experiments and tests were conducted at the Provincial Institute for the Deaf and Dumb at Belleville with a patented system known as the "Condor" system, but the results were not satisfactory. The chemical solution in this process was merely sulphate of iron.

In the following year the "Ferrozone 'Polarite'" process, another patented system, was experimented with at the Ontario Agricultural College, Guelph. Upon the recommendation of the late C. H. Horetzxy, of the Provincial Public Works Department, this system was subsequently adopted at the Mimico Asylum, at the Institute at Belleville, and at other Government institutions throughout the Province.

In 1892, the town of Berlin, Ontario, constructed sewage purification works, which were no doubt the first municipal works in Canada.

The population of the town at this time was about 7,500. Three miles of sewers on the separate system conveyed 125,000 gallons daily by gravity to a plot of land secured for disposal works. It was estimated that over fifty per cent. of the flow represented subsoil infiltration.

Of the twenty acres purchased, five acres at least were unfit for use. Eight acres were originally laid out into four flat beds, cosely underdrained, and separated by embankments.

For three or four years the results were quite satisfactory, notwithstanding as much attention appears to have been given to the raising of crops as to the treatment of the sewage. During the winter months the sewage was permitted to flow directly to the small stream with a volume of three cubic feet per second, and only one attendant was engaged in the summer to apply the sewage to the beds in rotation.

In 1896, the Provincial Board of Health investigated certain complaints of riparian owners below, and four years later a small septic tank was added, also two filter beds for experimental purposes.

In 1894, the town of Waterloo followed the example of Berlin and constructed several beds for sewage treatment.

In 1896-97 the city of Hamilton constructed chemical precipitation works at Wentworth street, and in 1898 similar works were constructed at Ferguson avenue, since which they have been in continuous operation. These works were the first municipal precipitation works in the province. The sewage is precipitated by carbonate of lime and sulphate of alumina, the sludge pressed by Johnson presses, and the resultant cake sold or given away to market gardeners, or burned, according to the supply and demand.

Deodorants and disinfectants have been experimented with in several places, but Hamilton has adhered to precipitation, and the satisfactory results are due largely to the original design of the works. The effluents may not be non-putrescible, but the grosser solids are removed.

Of the various proprietary processes experimented with in England, one of the first to receive attention here was the "Amifies" process, but it does not appear to have been adopted at any place in Canada. The "Porous Carbon" system was experimented with, but the results were not considered as satisfactory in either case.

The "International System" of purification by the use of "Polarite" and "Ferrozone," having been adopted at several of the provincial institutes, was thus brought into public notice. A company soon took advantage of this and rosy pictures were painted by promoter artists at Toronto, Stratford and London. In the latter city, in 1898, the system would have been adopted for treating the sewage of the entire city if the engineers acting for the city had not pertinaciously opposed the scheme.

The parent company of the International system was organized in England, and a subsidiary company at Detroit, Michigan, from which point Canada was exploited. Several towns in the United States adopted the system to their sorrow, the most notable instance being Madison, Wisconsin.

After a few years' contributions had been paid to the parent company for supplies of Ferrozone and Polarite, the Provincial Government decided to experiment with sand, gravel, etc., and made the discovery that with selected materials the results were quite equal to those obtained with Polarite and Ferrozone. This process then passed from the Canadian stage of action, to be succeeded by the Septic Tank System, promoted by a syndicate. The claims made for this newly discovered method of sewage treatment were little short of miraculous, and immediately attracted the at-

* Presented at Annual Meeting of Canadian Public Health Association, Montreal.

tention of sanitary authorities in Canada, but it does not appear that any tanks were constructed by municipal authorities in this country prior to 1901.

At Berlin a second investigation was made by the Provincial Board of Health in 1901, the evidence demonstrating that the beds were of insufficient capacity to treat the flow, which had increased to 350,000 gallons of very strong sewage per day. The beds were found to be overworked, waterlogged, full of sludge, and the authorities were at the same time endeavoring to raise crops.

In 1902 the Legislature appropriated $2,000 to carry on experimental work in the interests of the municipalities in the province, which experiments were made at Berlin. As a result the town decided to construct:—

(a) Two septic tanks.

(b) To pump the affluent of the tanks.

(c) To adopt intermittent downward filtration.

Fourteen acres of high gravelly land subdivided into sixteen beds, were selected adjoining the original "Sewage Farm," as the public persisted in calling the works.

In Dr. Amyot's report upon the Berlin experiments of 1902, the system of treating sewage by contact beds was clearly described, as well as the results of experiments with effluents from septic tanks, Stoddard trickling filters, and Intermittent sand filters.

In 1900-1901 the city of Stratford constructed Sewage Disposal Works, comprising intermittent filtration beds, which were soon overworked and outgrown. Additions were made in 1904-1905 and a septic tank constructed.

Ten years ago four municipalities in the Province of Ontario had constructed sewage disposal works:

(1) Berlin—Filtration beds, 1892. Experimental septic tanks and two small filter beds, 1901.

(2) Waterloo—Filtration beds, 1894.

(3) Hamilton—Chemical Precipitation Works, 1896-7.

(4) Stratford—Filtration beds and small septic tank, 1901.

The sewage from several provincial institutions was also being satisfactorily treated.

Two or three experimental septic tanks had been constructed, but the boom of the next decade had not commenced.

As a result of a series of experiments carried out by Mr. D. Cameron, the city surveyor of Exeter, England, a syndicate was formed and patents secured in Great Britain, the United States, Canada, and other countries throughout the civilized world for the septic tank system. By 1900 the city of Exeter had become a Mecca for engineering pilgrims, and within a few years Cameron tanks or similar tanks were being constructed not only throughout Great Britain but elsewhere, and generally without consulting the Cameron company. This company claimed the following advantages for their system:—

1. The non-production of sludge.

2. An effluent in the best condition for irrigation or filtration.

3. Filters were recommended by the company to purify the tank effluent.

4. A process free from nuisance.

5. Automatic and absolute reliability in working.

6. The first cost was within the reach of all communities.

7. Working expenses were practically nil.

It is not surprising that the Septic Tank System especially attracted attention in Canada, where climatic conditions were more severe than in Great Britain, and the problem of sludge disposal not as well understood.

The first municipal septic tanks to be constructed in Canada were probably the small ones at Berlin and at Stratford.

A larger tank was built at Stratford in 1904, and in the same year two tanks were built by the city of Guelph. The following places constructed septic tanks between 1904 and 1911, approximately in the order given:—

Peterboro, Toronto (Woodbine area); Vancouver, B.C. (in part); Regina, Sask.; Moose Jaw, Sask.; Berlin (No. 2); North Bay, London, Woodstock, Brampton, Barrie, Vernon, B.C.; St. Thomas, Guelph (No. 2); Haileybury, New Liskeard, Orillia, Oshawa, Bridgeburg, and probably other places.

Hundreds of smaller tanks were also constructed for public institutions and private residences, of which there are no records.

In 1910 the Cameron Septic Tank Company, of Chicago, threatened suit against a number of municipalities in Canada for infringement of patents, which had been declared valid by the Superior Courts of the United States, although it would appear that in Great Britain the patentees did not press their claims for royalties.

The most important claim of the company, the non-production of sludge, was soon proven untenable. The discovery was also made that it was not essential that the tanks should be made air tight, and the light excluded, also that the utilization of the evolved gases was more than offset by the risks from explosions.

The Canadian septic tank boom of the last ten years has commenced to subside, but engineers have profited largely by the experience gained.

The removal of part of the matters in suspension renders the sewage more amenable to further treatment and prevents the clogging of beds and filters. The refuse from certain manufactories, such as sugar refineries, breweries, etc., may, however, neutralize this effect by rendering the sewage acid.

Many of the tanks constructed during the last five years have been more correctly called sedimentation tanks, sludge removers, rather than sludge digesters.

The "Imhoff" tank is at the present time prominently in the eye of the public, due largely to the characteristic energy of the promoters of a patented process or article. Dividends must be earned by royalties paid.

The irrigation beds at the London Asylum, at Berlin, Waterloo and Stratford, were practically identified with the downward intermittent filtration system of New England.

The contact bed system evolved from the above system has not had the popularity in Canada enjoyed by the filtration beds or by the septic tank system, owing largely to the expense involved in properly applying the sewage. Contact beds were constructed by the city of London in 1901, by Stratford in 1904, and by Geulph in 1910, also by the city of Toronto at Woodbine avenue, in connection with the Cameron septic tank installation.

Hydrolytic tanks do not appear to have been adopted by any municipality in Canada, but experiments were to have been made at Edmonton in 1910, the results of which should soon be made public.

Percolating and sprinkling filters are now being adopted by a number of municipalities throughout Canada, but none are as yet in operation so far as the writer is aware, excepting the percolating filter of the Stoddard type at Vernon, B.C.

At the present date the engineers favor tanks for the removal of the grosser solids by sedimentation, the treatment of the effluent upon filters, and the disinfection of the filtrate after a second sedimentation.

By the end of the decade now dawning, every inland city and town in Canada will probably have adopted some method of sewage purification. Such works must be carried out by the municipal engineer, with the assistance of the chemist and the bacteriologist, and we have much preparatory work to do, not only in educating the general public and their representative councils, but in conducting experiments with systems now in operation and in collecting data in advance of designing and constructing.

PUBLIC UTILITIES.

The problems of the valuation of public utilities have been prominently before the Canadian public, the question of the purchase of the Toronto Street Railway and the Winnipeg Street Railway having been recently discussed.

At the recent International Municipal Congress Mr. Bion J. Arnold, chairman of the supervising board of engineers of Chicago said:

"During the last twenty-five or thirty years the most of the great inventions which have made possible the public utility corporations of to-day came into existence. During the early part of this period inventors were rivaling each other, promoters were doing their best to outwit each other, financiers were doing the best they could to gain in financial profit in promoting various enterprises, or backing different enterprises in order that the financial profit might be realized; so that we might say the first ten years of this period was one of strife on the part of all people interested in the matter—and all were interested in it, inventors, promoters, financiers and the public—they were all interested in the final result.

"During this period franchises were granted to public utility corporations upon easy terms. And perhaps it is well that they were so granted, because the public was desirous of securing the advantages of the public utility corporations, and the public also was without the knowledge as to the terms such franchises should be granted upon. And it took some years of experience in the operation under those corporations and under our modern conditions before those facts could be learned..

"The result was that competitive franchises were granted in cities to lighting companies, electric railway companies, to gas companies, to water companies—seldom, however, to water companies, but sometimes—on the theory that competition was the best thing for all concerned, that the greater the competition the lower the cost of production and consequently the lower cost to the consumer. We have since learned that that meant the duplication of capital in many instances, which has since been consolidated into one large company—usually with a profit to both parties—and the result is that the public is carrying to-day a capitalization upon public utility properties that it never should have been asked to carry, and never would have been, had it not been for this competition principle which was followed at that time. We did the best we knew under the circumstances.

"During the past ten years, however, certain corporations which have been granted those privileges had misused those privileges—I do not say all of them but certain ones had—the resulting overcapitalization and the fixing of rates made the public pay higher than it should. As soon as these conditions became known to the public and the franchises of the original corporations began to lapse, then the day of settlement came. These original promoters of these companies, not having understood what depreciation meant, and furthermore, going upon the theory that when franchises lapsed they would be renewed by the municipalities, and also upon the theory that when it became necessary to rehabilitate the properties, they could issue new securities and additional securities for money to rehabilitate with—I say, going upon those two theories, no allowance was made for depreciation and in many instances not sufficient allowance was made for maintenance—maintenance as distinguished from depreciation, meaning the ordinary upkeep of wear and tear, depreciation meaning the natural wear of the property that must be kept up by maintenance or upkeep, or that wear which comes out of the property, necessitating its being renewed.

"For instance, a car may be bought to-day. You can buy new brake shoes, new wheels, new seats, new mats for the floor, etc., and keep it running. That is maintenance. But when that car becomes obsolete or completely worn out and has to be renewed with another car, then comes in renewal or depreciation. And the difference between the value of the original car and the value of the new car—we will assume that the new car was substituted at the same value as the old one—you must provide sufficient money to buy a new car with. It is that value that I call renewals or depreciation. I say, no allowance was made for this in the original promotion of these enterprises in many instances; in fact, I know of no instance in this country where that was allowed.

"Now, what is the result? We have found ourselves, when these franchises lapsed, with dilapidated properties and no money to rehabilitate them, and so highly capitalized that the companies could not stand additional securities in many instances. That is the situation that confronts numerous corporations in this country to-day. It confronted more five years ago than it does now.

"In some cities the problem has been met and solved. It has been met and solved in Chicago, in Cleveland, they are endeavoring to solve it in New York, Detroit, Pittsburgh, Seattle and San Francisco.

"There is a fair basis of settlement between the companies and the public. It has taken me about nine years to come to the conclusion as to what that fair basis is in my own mind, and having had more or less to do with these questions between the public and the corporations, first representing one side and then the other, and sometimes both sides of the same case by agreement, I have given it some thought.

"And I have come to this conclusion, that where a corporation has been honestly managed, judiciously managed from the day of its inception to date, notwithstanding the fact that it may have put in horse cars, light rails and had to renew them, so that if you go out and look at that property to-day you will find no value for those cars or rails—suppose it paid the promoters a profit, suppose it paid a discount on securities in order to raise the money to float the proposition at this time—I say, all such things as that, obsolescence, discounts on securities, reasonable promoters' profits, legal fees connected with the organization, things of that character which cannot be found to-day in the property if you go out and look at it and make a value upon it—I say, such things as that are rightfully a part of the original cost of the property and should be allowed to stay in the capitalization of the company until the parties who have put their money into the property have had a chance to earn that money out, with a fair return upon it.

"So I say if you take the records of a company from the date it was organized up to date and allowing a fair return—I would say a good, liberal rate of interest upon every dollar that went into the property up to date, deducting from what you allow the difference between what the company actually took out in dividends and what it ought to have received upon this basis, then the difference left over and above the value of the physical property that you find to-day should be allowed to stay in the capitalization until the company can earn it out.

"In other words, if the company is to be regulated now, as it often is in many instances where public service commissions are in vogue, and this public service commission, or the public, says: 'From now on you can earn a fair return upon the real value of your property, or upon some valuation'—in other words, 'You are not going to be allowed to make excessive profits any longer, we are going to regulate you from now on'—I say that under such conditions the company has a right, and has a right to demand, that it be allowed to earn a liberal return upon the real money that was put in from the date that the money went in up to date, and that even from this time on after the rate of return is agreed upon between the public body and the public corporation—call it six per cent. if you choose—that all over and above that six per cent. shall go into an amortization fund to gradually retire the difference between that real value of the property as it exists and this obsolescence, promotion fees, etc., which I have named, so that eventually the property will be paying a return simply upon the value of the physical property performing the service.

"Now if I make that clear, suppose that a company has $100,000 worth of physical property to-day. Suppose it has shown it has put in $120,000 in real money, that is, on this basis I have figured, say at eight per cent. from the time it went in. There is a difference then of $20,000 that there is nothing to represent at the present. I say, the company is entitled to earn a return upon that $20,000, in addition to the real value of $100,000, at six per cent., we will say, and to continue to earn it upon that, and all that it earns over that six per cent. shall go into a fund to gradually retire the $20,000 I have mentioned, so that finally the property is paying a return simply upon $120,000 worth of property. The best way to do that is gradually to increase the property to the amount of the $20,000 by gradually putting that money into real physical property."

IMPROVEMENT OF PUBLIC HIGHWAYS ACT.

The amendment to the Ontario Act to aid in the Improvement of Public Highways, will be of interest to engineers. The following are the changes which are of importance:—

The sum of $1,000,000 is set apart out of the consolidated revenue fund to aid in the improvement of public highways.

The said sum shall be in addition to any sum heretofore set apart for the like purpose, and shall be applied as provided by the Act to Aid in the Improvement of Public Highways, passed in the seventh year of the reign of his late Majesty King Edward VII., chapter 16, and amendments thereto, and subject to the same terms and conditions as the fund set apart by that Act.

Section 2 of the said Act is amended by adding thereto the following subsections:

(a) The council of every county in which road improvements are undertaken under this Act shall by by-law designate an engineer or some other competent person subject to approval by Minister of Public Works to act as county road superintendent under the direction of the council.

(b) No grant shall be made to any county under this Act until subsection a has been complied with.

(c) The county road superintendent shall place some competent person as foreman or inspector in charge of any work which it is impossible for him to personally oversee, and it shall be the duty of the foreman or inspector to see that the work is properly carried out.

(d) No member of the council of the county and no member of the council of any local municipality in the county shall be appointed or act under subsections a or c or be employed by the county road superintendent in any capacity, and any such member who is appointed, or who acts or is employed in contravention of this subsection shall be disqualified from sitting or voting in the council of which he was a member at the time of his appointment or employment.

The treasurer of every county shall, before the first day of March in each year, make up and transmit to the Minister of Public Works a detailed and audited statement of all expenditure upon, or in connection with, county roads or bridges for the next preceding calendar year. The statement shall be in such form as the Minister of Public Works may direct. The treasurer shall forthwith publish the statement at least once in a newspaper, published in the county town. The clerk of the county shall procure not less than one hundred copies of the statement and shall deliver or transmit by post one of such copies to each of the electors who shall first make request for the same.

Section 6 of the Act is amended by adding the following: "Or the council instead of raising money by debentures may provide the money required out of county funds, or by an annual county rate in the manner authorized by the Municipal Act, and all the provisions of this Act shall apply to any moneys heretofore or hereafter so provided as fully as if debentures had been issued, whether a by-law transferring such moneys to a special account under this Act has or has not been passed."

Section 12 of the Act is repealed and the following substituted therefor: "All highways designated and assumed by a county council in accordance with section 2 of this Act, except as in subsection 3 of section 2 otherwise provided, shall be maintained and kept in repair by the corporation of the county in which such roads are situate, and in all cases of doubt or dispute as to what constitute works of maintenance or repair, and what constitute works of construction and the purchase and maintenance and repair of road machinery, plant and equipment, properly chargeable under this Act, the decision of the Minister of Public Works shall be final; provided that after the expiration of three years from the final construction and completion of the county system of roads, which shall be so declared by the Minister of Public Works, the county council may, with the approval of the Lieutenant-Governor in Council and of two-thirds of the minor municipalities in the county expressed by by-law, declare that such system of county roads shall, on the 1st of January following, revert to the local municipalities in which the same are situate, and such roads shall thereafter be maintained in the same manner as township roads."

Where it is found by the Minister of Public Works that any highway assumed by the county council under the Act, has ceased to be, or for some other reason is not of sufficient importance to be constructed and maintained as a county road, such road or section thereof may be struck off the approved plan of county roads, by the Lieutenant-Governor in Council, and such road or section thereof shall thereupon revert to the local or township municipality in which the same is situate.

The Act is amended by inserting therein the following section:—

(1) The Minister of Public Works may arrange with the corporation of any local municipality for the construction or improvement therein of an object-lesson or experimental road, or of more than one such road.

(2) The Minister may lay out, construct, improve and complete any such road and the Public Works Act shall apply to anything done by him under this Act.

(3) The cost of material, labor, special engineering or other services, plant, machinery and equipment and the repair and maintenance of plant, machinery or equipment in or about any work undertaken by the Minister under this section or incidental thereto, shall be paid out of the fund set apart under this Act, upon the certificate of the Minister and for that purpose accountable cheques may from time be issued against such fund in favor of the Minister, upon his requisition therefor.

(4) A road shall not, by reason of its having been constructed or improved under this Act, become or be the property of the Crown, but every such road after its construction or improvement shall be under the jurisdiction of the council of the municipality in which it is situate and shall be maintained and kept in repair in the same manner as other roads in the municipality.

When any highway leading to, or adjacent to any city or town separated from the county is widened, strengthened, reconstructed or otherwise improved or requires the expenditure of a greater amount for maintenance and repair to meet the requirements of increased, heavy, constant or other extraordinary traffic to and from such city or town, beyond the requirements which, but for the existence of such city or town, would be deemed those of a standard highway for the locality, the corporation of such city or town by by-law passed with the assent of at least two-thirds of the members of the council thereof may agree with the corporation of the county to contribute such additional cost, or a proper proportion of the cost, or that the amount of the contribution of such city or town shall be determined by arbitration under the Consolidated Municipal Act, 1903, and may, without the assent of the electors, provide by by-law for the issue of debentures payable in not more than twenty years from the date of the issue thereof to raise the amount agreed upon or awarded, or may agree with the corporation of the county for the payment of such amounts in annual instalments to be raised by annual special rate upon the rateable property in the city or town.

The council of any county may assume as a county road under this Act, any main or leading road or roads through or within such county, and where such road or roads do not serve all townships equally, the county council may, with the approval of the Minister of Public Works, omit from assessment any township or townships through which such road or roads do not pass, or may assess any or each township through which such road or roads pass for a larger or smaller amount in order to equitably assess the cost; or the council of any county in which a system of roads is established may, upon the application of a township council, and with the approval of the Minister of Public Works, levy a special rate upon the township for the construction, improvement or maintenance of the county road or roads within such township.

SUMMER SCHOOL.

Announcement is made of the twelfth annual six weeks summer school of the College of Engineering of the University of Wisconsin, which opens on the twenty-fourth of June.

Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, testing of materials, machine design, shopwork and surveying, in addition to which subjects may be taken in the College of Letters and Science.

For bulletin, address F. E. Turneaure, University of Wisconsin, Madison, Wisconsin.

RAILWAY, TELEPHONE AND OTHER POLES.

The statistics for the poles purchased during 1910 in Canada were obtained from the telephone, telegraph, electric light and power and electric and steam railways operating in Canada. Reports were secured from 559 companies, about 89 per cent. of the total number in operation, by Mr. H. R. MacMillan, of the Forestry Department, Ottawa. Electric light and power companies numbered 291, telephone companies 161, steam railway companies 62, electric railway companies 41, and telegraph companies four. Of these companies 283 operated in Ontario, 94 in Quebec, 39 in Nova Scotia, 35 in Saskatchewan, 27 in Alberta, 23 in New Brunswick, 23 in British Columbia, 17 in Manitoba, 10 in Prince Edward Island, and eight were United States Companies operating in Canada.

The total number of wooden poles purchased in Canada during 1910 was 782,841. The gain over the number reported for 1909 was 434,586, or 118 per cent., due partly to the increased building of steam railway and rural telephone lines. The total value at point of purchase was $1,043,874, which was an increase of $546,822 over the value in 1909. The average cost of poles was $1.39 in 1909 and $1.33 in 1910. The decrease of six cents was due to an increase in the use of short cedar poles by telephone and telegraph companies.

Cedar is the wood most frequently used for poles in Canada, as it is practically the only Canadian wood growing to a convenient pole size which is cheap, easily handled and durable. There were 758,209 cedar poles purchased in Canada in 1910, or 99.2 per cent. of the total. Spruce, furnishing 0.7 per cent. of the total, stands next in the list, having increased in use 175 per cent. over 1909. One-tenth of one per cent. of the total is made up of chestnut, larch and Douglas fir.

The unspecified are, on the average, more expensive because a small proportion of them belong to high length-classes and may include some treated poles. The use of larch has decreased from 14,401 poles in 1909 to 73 poles in 1910. The increased use of spruce accounts partially for this, but the difference is mostly due to the fact that a local telephone company building through a larch district in 1909 in the West used larch poles entirely, but did not build lines in 1910.

Chestnut, hitherto taken with unspecified, was this year separated. All chestnut poles are imported from the United States.

In 1909 pole users were classified under three headings: (1) Telephone and telegraph; (2) steam roads; (3) electric roads, power and light. It was found difficult to properly separate the first two, and in 1910 only two divisions are made: (1) railways, telephone and telegraph, and (2) electric roads, power and light. In 1910, as in previous years, the important class was that including the railway, telephone and telegraph companies, which purchased 744,387 poles or 95.1 per cent. of the total number reported. The use of poles by these companies was 119 per cent. greater in 1910 than in 1909, the increase being all in cedar.

This increase in the use of cedar is also seen in the consumption by electric roads, power and light companies, which used 113 per cent. more cedar in 1910 than in 1909. These companies bought 38,454 poles in 1910, or 4.9 per cent. of the total.

For the steam railway, telephone and telegraph companies the average cost of poles purchased in 1910 was $1.20 per pole; and for electric railway, power and light

companies, $3.98. The difference in these average prices indicates the difference in the size or grade of the average poles suitable for the purposes of the two classes of companies.

In the shorter length-classes, as the 20-to-25-foot class, which composes 75 per cent. of the total number used, it is seen that chestnut is cheapest, then cedar, larch, spruce and Douglas fir. This in itself would explain the great popularity of cedar, for it gives for the money more service than any of the other native woods used.

The prices paid for poles range from $1.01 for chestnut poles 20 to 25 feet long to $7.39 paid for poles of unspecified species 41 feet and over. In general the value of poles advances very rapidly, though not proportionately, with increasing length. The one instance in the 31-to-35-foot class in which spruce poles were bought for 51 cents may be explained by the purchase of the poles in a locality of Nova Scotia where woods have comparatively low value.

Cedar poles appear in every length-class, and form the largest proportion. Spruce also is found in every class, but neither chestnut, larch nor Douglas fir were used over 30 feet in length.

In the thirty-foot class cedar poles are more expensive in Canada than in the United States. Above thirty feet they become cheaper. As seventy-five per cent. of the poles used in Canada are thirty feet or less in length, this means that companies using poles pay more for them, on the average, in Canada than in the United States. At present Canadian users are paying no attention to preservative methods, which in reality increases still more the relative cost. The pole-users of the United States, though paying less for their poles, treat them at a small extra expense, thus increasing the life of the pole and decreasing the yearly cost.

Spruce poles cost more in Canada than in the United States in 1909, except in the 20-to-25-foot class. In this short-length class the cost is 13 cents less per pole in Canada. In the 26-to-30-foot class they cost 35 cents more in Canada than in the United States. In lengths of 31 to 40 feet and over, spruce poles cost from 11 cents to 64 cents more per pole in Canada.

In 1910 poles were exported to the United States and other countries to the value of $74,708. Imports into Canada consisted of 138,285 cedar poles worth $139,486, making an excess of imports over exports of $64,778. These imported cedar poles cost $1.00 per pole and belonged to the 25-foot length class.

Poles, as at present used in Canada, receive no protection against decay in the parts in contact with the soil. The result is that moisture is drawn into the pole, fungus growth is supported and the pole is useless in a short term of years. This unnecessary waste may be done away with and the cost per annum of a pole line may be decreased by treating the poles with certain preservatives. According to information obtained from the Forest Service of the United States, 576,631 poles or 15.4 per cent. of the total used, received such treatment before use in 1909.

In 1908, 10.6 per cent. received such treatment. This increase within a year of nearly 50 per cent. in the use of chemical preservatives shows that the experiment is successful and that it is making poles less expensive. As has been shown, 75 per cent. of the cedar poles used in Canada are from 20 to 40 cents per pole more expensive at the point of purchase than similar sizes in the United States. Evidently it pays United States pole-users to use preservatives with cheap poles. It would, therefore, pay Canada much more to lessen the annual cost of her more expensive poles by lengthening the life of the poles.

It requires from 175 to 200 years to produce the average cedar pole, which, if left unprotected, will rot and be useless in fourteen years. This species, forming 99.2 per cent. of the total number used, grows entirely in the southeastern part of Canada. At present the yearly consumption far exceeds the annual growth. Under the present methods of exploiting the forest, cedar will become commercially extinct in a few years. It is absolutely necessary that some method be adopted to avoid this catastrophe. The easiest means is to adopt the general use of preservative treatment to lengthen the life of cedar and to make other species, not naturally decay-resisting, available for pole use.

Untreated cedar poles, thirty feet long, cost, when the pole is in place, $7.00, and last on the average fourteen years. This is an annual cost of 71 cents per pole, allowing interest on a five per cent. basis. By the creosote brush treatment, which consists in applying the preservative to the pole by hand with a brush, the cost of each pole is raised to $7.20. These poles have a life of seventeen years, making the annual cost 64 cents per pole, or reducing the cost seven cents per pole per annum. If the open-tank treatment is used, which consists in saturating the poles in alternate hot and cold preservative baths of creosote, the cost per pole is $8.05. These poles last 22 years, which makes the annual cost 61 cents per pole, or 10 cents less per pole than with untreated poles. The use of preservatives is both a saving of expense and a saving of the forests.

Spruce, though at present forming only 0.7 per cent. of the total (5,524 poles being used in 1909) should receive attention.

It is a tree which grows to useful pole size in 60 to 100 years, is cheap, light and easily handled. The reproduction of spruce is excellent. It occurs naturally over large areas in Canada, and, under present conditions of logging, is reproducing rapidly. It is adapted to many kinds of soil and the species is quickly propagated by seed. Untreated, the wood is not durable, but if treated it will last as long as the naturally durable and more expensive species used at present.

Preservative treatments will be of no particular benefit to the lodgepole pine of the West, used chiefly for mining timbers and props. This species is of suitable pole size and occurs extensively on the mountain slopes of Alberta and British Columbia. As an untreated pole, it decays quickly in contact with the soil, lasting about five years. The tree grows tall and straight with very little taper and makes a well-shaped pole. Large quantities of this timber have been killed by fire. The dead trees are now standing thoroughly seasoned and in excellent condition for effective treatment. The sapwood is about an inch thick and is easily impregnated.

It would cost $1.40 per pole to treat by the tank method 35-foot poles of this species. Such a treatment would increase the life of the poles to 20 years, an increase of 300 per cent. over their present life.

The adoption of the preservative treatment of poles would result in a great saving to the pole-users of the prairie provinces. Cedar from Eastern Canada is now used almost exclusively for poles in the prairies, and because of the long freight haul is very expensive. Close to the pole-lines of Western Canada there are large quantities of lodgepine and spruce. Poles of these species may be treated and set for less cost than untreated cedar poles and will give greater service than untreated cedar poles. This is an opportunity for economy which should not be overlooked by companies erecting pole-lines.

Metallurgical Comment

T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

FURNACE ELECTRODES PRACTICALLY CONSIDERED.*

By R. Turnbull.

A number of papers have been read at the various meetings of this society during the last two or three years, and articles published in the technical papers, on electrode losses, but, so far as I am aware, the practical end of the electrode question has never been taken up by any one of our members except in a very superficial manner.

It therefore occurred to me that as electric furnace practice is only confined to a very small percentage of the members of this society, and as there must be quite a number who have never encountered electrode troubles, and who may not understand what benefit the society is getting from the above mentioned discussion on electrode losses, that for these reasons a practical paper written on the subject of electrodes by one who has been in the business for a number of years might prove of some benefit to the members as a whole.

Before going into the history of the electrode, let us first see what relation is has to the electric furnace. Putting it in its simplest form, the electrode is to the electric furnace what the steam pipe is to the steam engine. In the latter case the steam or source of energy is carried to the engine in the pipe at a certain pressure, represented by pounds per square inch and the volume of steam by the number of cubic feet. To get more power, should the volume be increased the pipe must be made larger in diameter, in order to avoid frictional losses, etc. The same result could be attained, within a certain limit, by increasing the pressure and allowing the volume to remain the same. In the case of the electrode, the pressure and volume of the steam are replaced by volts and amperes; an electrode, if large enough, will carry to the furnace a certain number of amperes with very little loss in volts, but as the amperes increase, the section of the electrode must also be increased, otherwise the loss in volts by resistance in the electrode will become serious and considerably decrease the output of the furnace. As in the case of the steam pipe, the pressure in volts might be increased in order to get more power into the furnace, but electric furnace operation is generally controlled by the voltage, and a variation from the usual number of volts would upset the good operation of the furnace.

Now let us examine what an electrode is composed of, and what constitutes a good and bad electrode.[1] The mixture used in the manufacture of the ordinary electrode is anything but a complicated one, being simply some kind of carbon mixed with certain percentages of pitch and tar. This, after being well mixed together, is moulded in some special apparatus to the desired form, and then baked in a furnace in a non-oxidizing atmosphere. This looks simple, and when one looks back on the troubles and tribulations experienced by technical men in electric furnace work over quite a number of years, due mainly to bad electrodes, it seems strange that the secret of making electrodes which would not break was not discovered long ago. But good electrodes were made from the very beginning, and it is quite possible that amongst the first batch of electrodes made some were equal in quality to the best electrodes made at the present day. This was where the great difficulty confronting the manufacturer lay, in his ability to, unintentionally, turn out a first-class electrode and a thoroughly bad one at the same time and under exactly the same conditions. Electrodes made at the same time, under the same conditions, and baked in the same furnace, have shown in actual service as many different characteristics in quality as could well be imagined, some giving excellent service whilst others simply went to pieces after being in operation for a few minutes.

As the electrode is to the electric furnace what the gasoline motor is to the aeroplane, one can well imagine what a bad electrode meant to the operator of the electric furnace; without the efficient gasoline engine the aeroplane would probably be unknown, and the same might be said would be the case of the electric furnace without good electrodes.

In the early stages of electrode manufacture petroleum coke was mostly employed, it being first of all calcined to drive off all volatile matter. This was afterwards replaced by retort carbon, a kind of coke which is deposited in the retorts in gas works, and which is nearly pure carbon. Better results were obtained by the use of retort carbon than with petroleum coke, and it was considered for a time the only material with which a reasonably good electrode could be turned out. I have not sufficient data to enable me to say when and where the first large electrodes were made, but I should not be far wrong in saying that they were first made by Dr. P. Héroult at his works in Froges, France, some fifteen years ago; at that time he made them as large as 16 inches (40 cm.) square and 6 feet (1.8 m.) long. Some of these first electrodes manufactured by him were very good, and some very bad, and little if any reliable data could be collected from his work. I should like to say here, however, Dr. Héroult has not abandoned the field, he having established works in Niagara Falls, N.Y., where excellent electrodes are now being turned out, and although the process used is different in some respects from his original one, he is still working along the same lines. His original process is still being used with good results at at Welland, Ontario, by Electro-Metals, Limited.

Now, what was the reason of so many failures to turn out a good article in the early days, and why do nearly all electrode manufacturers, even those who have been but a short time in the business, turn out to-day a fairly satisfactory article? I think I am not far wrong in saying that the main cause of failure was in the use of the wrong carbon material. Petroleum coke did not work well, and electrodes made from it crumbled to pieces in the furnaces. Retort carbon made a better electrode, but as this commodity was collected from gas works all over the world, a homogeneous article could not be counted upon, and this made its use dangerous to the manufacturer, so far as reliability was concerned. It was only when anthracite coal came into use that real progress was made, and the best kind of electrodes in use to-day are made from this material. Hardmuth, of Venisseux, France, was, if I am not mistaken, the first to use anthracite coal on a large scale, and for some time his electrodes were the best in the market. He was quickly followed by the German makers.

* Read before the American Electro-Chemical Society on April 19th 1912.

[1] There are two classes of electrodes, the amorphous carbon and the graphite; it is the former to which I wish to draw attention, as graphite is prohibitive for ordinary furnace practice, owing to its high cost.

the Plania Werke and Siemens. We are indebted to-day to the Plania Werke for the moulded screw, which enables electrodes to be joined together, thus doing away with the stub and machining of the electrode and the trouble of changing electrodes in the furnace. This screwed electrode applies mainly to furnaces for the manufacture and refining of steel. At the present time nearly all manufacturers are using anthracite coal as the carbon base, and while electrodes made by some manufacturers are superior to those made by others, this is mainly due to the different methods of moulding the electrodes and preparing the coal employed.

So much progress has been made in this industry in the last two or three years that perfectly satisfactory electrodes up to 24 inches (60 cm.) in diameter and 7 feet (2.1 m.) long are now being made, whilst only a few years ago nothing over 12 inches (30 cm.) square and five feet (1.5 m.) long was satisfactory. No doubt still larger electrodes can and will be built, as electric furnaces are still growing in size, and the time is not far distant when steel furnaces of 30 tons' capacity, and operating with electrodes three feet (0.9 m.) in diameter, will be as common as are our small 5-ton furnaces of to-day.

Before closing this paper, I would like to give a few hints as to the best manner of employing an electrode in order to ensure the best service and avoid the losses of which we have heard so much. Carbon, unlike metals, is a better conductor hot than cold, and the hotter it is, the better conductor it becomes. Carbon, however, even at a very high heat, is still a poor conductor, and it is impossible in actual practice to avoid some loss in the electrode itself. In all conductors, the longer the conductor, the greater the loss, but this loss can be lessened by increasing the size of the conductor. This same rule applies to electrodes, and in order to avoid all losses to the greatest extent possible the current should enter the electrode at a point as near as possible to the point where it will leave it. It is quite common practice to connect the metallic conductor to the head of the electrode, but this is a grave mistake, as the loss in volts in a long electrode will be from 4 to 6, depending on the current density employed, and in a furnace where the operating voltage is 50 volts, this loss would be equal to from 8 to 12 per cent. of the total energy consumed. Electrodes should be held in the same manner as one would hold a bar vertically in the hand, so that they can be taken at any point on their length, and in smelting furnaces the holder giving contact to the electrode should not be at any time more than 1 foot (30 cm.) above the charge. As the electrode wears away it is slipped through the holder, and the process goes on until it is finally taken by the head, but at no time should the part of the electrode carrying the current project more than 2 to 6 inches (5 to 15 cm.) from the holder itself. The losses, both of heat and energy, can be decreased by increasing the size of the electrode, but this can be carried too far. The writer would recommend a current density of from 30 to 35 amperes to the square inch of section (5 to 6 per sq. cm.) in order to keep the electrode as cool as possible and thereby prevent side oxidation and heat losses. With too large an electrode, quite a good percentage of the total energy supplied to the furnace would be required to keep the electrode warm.

An important point, the value of which is sometimes overlooked when considering the size of electrodes, is that it is often advisable to use electrodes of greater cross-section than electrical necessity demands, but for a totally different reason. In some processes, for instance, the electrode when working is surrounded to a certain depth by charge mixture. At the surface of such charge mixture, and therefore at some distance from the working end of the electrode, inflammable gases are given off, and these burning in air tend to attack and consume the electrode. Thus there is a tendency to reduce cross-section at this point with consequent increased current density, followed by rise of temperature, which further aggravates the condition described. It is, therefore, wise, for convenience sake, to use a larger cross-section so that the burning away does not result in eating the electrode through, letting a large piece of electrode into the charge and disturbing conditions generally This is one of the exigencies imposed by practice.

FERRO-SILICON, FERRO-CHROME AND FERRO-PHOSPHORUS.

Ferro-silicon, ferro-chrome, ferro-phosphorus, etc., have been made in electric furnaces at Buckingham, Que., by the Electric Reduction Company, Limited. The furnaces were not in operation during 1910. Ferro-silicon has also been made in electric furnaces at Sault Ste. Marie, and at Welland, Ont. The electric furnaces operated by the Electric Metals Company were in operation during 1910. These furnaces, constructed some three years ago, consist of four furnaces of from 1,000 to 1,500 horse-power each, the daily production being from 5 to 8 tons.

The imports of ferro-silicon, manganese, etc., during 1910 were 18,900 tons valued at $464,741, or an average of $24.59 per ton. The imports during 1910 were 17,699 tons valued at $411,536, an average of $23.25 per ton.

Returns of steel production received direct from the producers showed a total production of ingots and castings for 1910 of 822,284 tons, as compared with 754,719 tons in 1909, and 588,763 tons in 1908. In 1910 the production of open-hearth ingots was reported as 580,932 tons, Bessemer ingots 222,668 tons, direct open-hearth castings 18,085 tons, and other steels 599 tons; compared with 1909 there was an increase in total production of 67,565 tons, or nearly 9 per cent.

Statistics showing the quantities of the principal materials used in steel furnaces have been obtained for the first time for the year 1910, and it may be of interest to refer to these here. The total quantity of pig iron used in steel furnaces during 1910 was 690,913 tons: of which 601,219 tons were produced by firms reporting, and 89,694 tons purchased. The quantity of ferro-alloys used was 8,143 tons purchased. Scrap, etc., was used to the extent of 211,453 tons, being 140,913 tons produced by the firms reporting, and 70,540 tons purchased. Ores used included 1,317 tons of manganese ore and 39,332 tons of iron ore, while 144,110 tons of limestone or dolomite flux were used 7,461 tons of fluorspar. In Ontario a little over 600 million cubic feet of natural gas were used, while in Nova Scotia, coke oven gas was used at Sydney, of which a record of quantity is not obtained.

Complete statistics of the production of rolled products and of manufactured steel have not been received. Returns from seven of the largest producers show a production of blooms, billets, slabs, etc., of 628,100 tons, of which 580,533 tons were used by the producer for further manufacture, and 47,567 tons sold to other rolling mills.

The production of rails was 399,762 tons, of rods 88,456 tons, of bars 125,778 tons, of other rolled products 31,516 tons. The production of steel rails in 1909 was returned as 377,642 tons, and in 1908, 300,935 tons.

CHEMISTRY IN SWEDEN.

Chemistry has played an important part in the industrial history of Sweden. No less than twenty of the known chemical elements have been discovered by Swedes.

EXPERIMENTS ON HEAT INSULATION.*

By F. A. J. FitzGerald.

At the twentieth general meeting of this society a paper[1] was presented describing an electric furnace experiment in which it was found that the heat losses were so great that the furnace was not commercially practicable. It was also observed that by placing a layer of special heat insulating bricks wherever practicable on the outer walls of the furnace the heat losses were much diminished.

The very serious consequences of not attending properly to heat insulation led to an attempt to study the subject of heat losses, and the following paper describes some of the preliminary experiments.

Energy which should be usefully employed in the electric furnace is lost in various ways: Current leakage, generation of heat in the cables and other means for conducting the current into the furnace, conduction, convection and radiation of heat by the furnace walls, etc. In many furnaces there can be little doubt that the most serious loss of energy is that due to the escape of heat through the walls.

In the study of this subject we have no data which enables us to make calculations of the heat losses which will occur with different materials and under various conditions. No doubt there have been careful and valuable investigations made on the heat conductivity of materials and some experiments on the emissivity of hot bodies. Little information is available as regards convection. When such data as we have on these various causes of heat loss are examined and an attempt made to calculate probable losses the results are usually most unsatisfactory. On the other hand it is still more unsatisfactory to construct electric furnaces and find that they are commercially impracticable because the heat loss through the walls is such a large percentage of the total heat generated in the furnace.

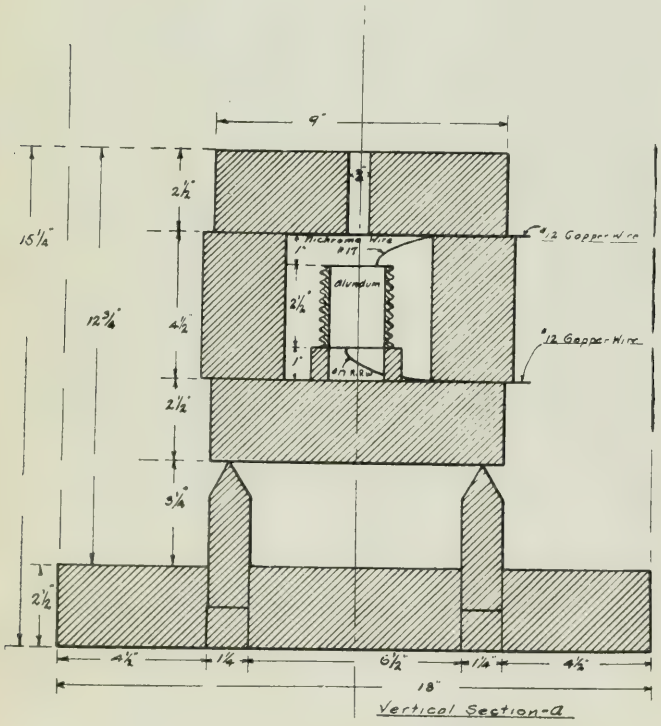

Fig. 1.

The ideal method of studying the subject would be to make the necessary experiments to determine the heat conductivity of the various materials to be used in constructing the walls of furnaces, to make measurements of the emissivity of the heated walls and so forth. But when the plans for such an investigation are made it is soon seen that much time and expense is involved. Under these circumstances it was thought to be more immediately useful to determine by comparatively simple experiments what materials would give the minimum loss of heat. By such work a great many materials could be immediately rejected and those which gave good results would be more fully investigated.

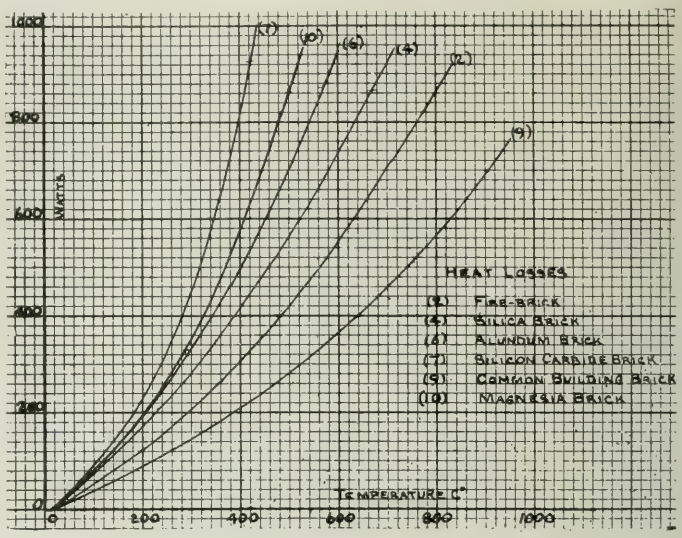

Fig. 2.

The apparatus used in the experiments is shown in Fig. 1. The furnace is constructed of the bricks under investigation and is heated by means of a resistor of "Nichrome" wire through which the current is passed. The resistor is connected to the source of current through a rheostat so that the rate of generation of energy in the resistor can be regulated, and means are provided for accurately measuring this rate. The method of making a test is to regulate the current so that a definite temperature is reached in the furnace and then to continue heating until the temperature becomes perfectly constant. As a rule a single determination takes several hours and the temperature is not considered constant until the readings of the pyrometer show no variation for at least two hours. When the temperature is constant the rate of generation of energy in the resistor is determined and this gives the rate at which heat is escaping through the furnace walls, neglecting what escapes by conduction through the leads going to the resistor and through the wires of the pyrometer thermo-couple. In nearly all cases four determinations at temperatures ranging from 200° to 900° were made for each of the materials tested.

From the data obtained as described above, curves were plotted in which the abscissas are temperatures and the ordinates watts.

In Fig. 2 are shown the curves obtained with several different bricks.

No. 2 is a fire brick of moderately good quality, that is to say, it is not of any special make. It was the brick used in constructing the furnace referred to in the paper mentioned above.[2] The maximum temperature reached in the brick testing furnace was 800°.

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* Read before the Am. Electro-Chem. Soc., April 18, 1912.

[1] "Note on an Unsuccessful Furnace Experiment," F. A. J. FitzGerald. Transactions 20, 89 (1911).

[2] Ibid.

No. 4 is the curve for a silica brick. It is interesting to note that in the paper already referred to it was said:

"It was recognized that silica brick are better heat insulators than fire brick, as may be seen from Wologdine's determinations[3] which show that the heat conductivity of silica is 0.0020 and of fire brick 0.0042."[4]

It appears, however, that in spite of its low heat conductivity this particular silica brick is not a satisfactory insulator. The maximum temperature reached with the silica brick was 670°. The heat loss here was 36 per cent. greater than with the fire brick. It is not very safe to theorize as to the cause of this phenomenon, but it looks as though the radiation from the surface of the silica brick is very much greater than from the ordinary fire brick. The vast differences due to the nature of the radiating surface is not so surprising if a familiar household phenomenon is considered, viz., the great difference in the rate of cooling of the common black iron kettle and the polished silver tea pot.

No. 6 was obtained from an alundum brick, one of the highly refractory ones made by the Norton Company. The transmission of heat was so rapid with this brick that the maximum temperature obtained in the furnace was only 570°. This illustrates well the value of such alundum refractories as crucibles, muffles, etc., where it is desirable to have as efficient transmission of heat as possible.

No. 7 is the curve for a brick made of silicon carbide. The brick is pure silicon carbide, that is, no bond is used in making it. The transmission of heat is extremely good with this brick so that the maximum temperature reached in the furnace was only 420°. Comparing this brick with the fire brick (2) when the temperature in the furnace was the same (420°) it is seen that the rate of escape of energy is 920 watts and 300 watts respectively, or more than three times as great in the case of the silicon carbide brick.

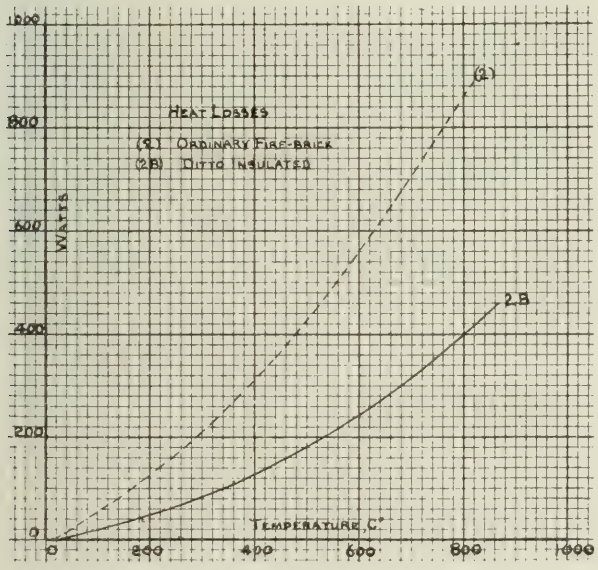


Fig. 3.

Curve No. 9 is that for an ordinary red building brick of the cheapest kind. It is seen to be the best insulator of any of this lot, the heat losses being as much as 34 per cent. less than those for the fire brick (2) at a furnace temperature of 800°.

Curve No. 10 shows the results obtained with a magnesia brick. This was of a standard kind made of brown magnesia and not the Grecian magnesia variety.

[3] Electrochemical & Metallurgical Industry, Vol. VI. (1909), page 383.

[4] These Transactions, Vol. 20, 89 (1911).

In Fig. 3 are shown the results obtained, first with the ordinary fire brick (2) and then after covering the whole furnace built of this brick with a 25 mm. (1 inch) thickness of a special heat insulating material kindly supplied by a well-known manufacturer. It will be observed that this material reduced the heat losses by more than 50 per cent.

In Fig. 4 is a comparison of the heat losses obtained with the ordinary fire brick (2) and a brick specially constructed for heat insulation. Here it will be observed that in the case of the special insulating brick the heat losses are reduced 68 per cent.

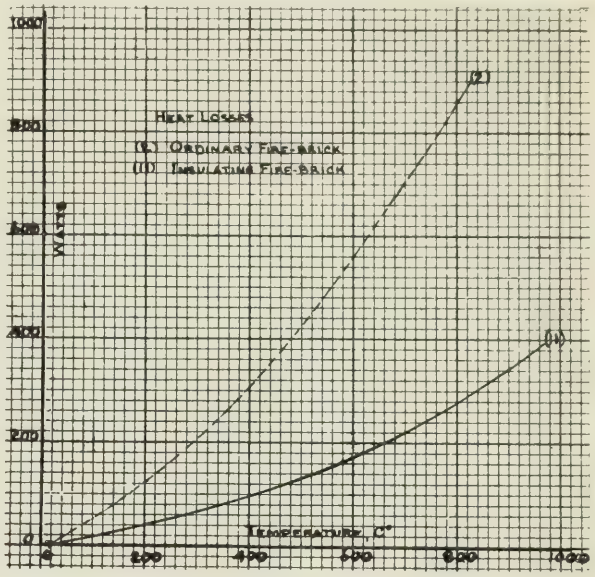


Fig. 4.

The first object of this work is to make a study in the quickest way possible of the heat insulating properties of various kinds of brick used in building furnaces and get some notion of the amount of heat lost with such materials. The ultimate object in view is the production of a heat insulating article, the cost of which will be less than that of the watt-hours uselessly dissipated through furnace walls.

TERMINAL BRAKE TESTING.*

By F. B. Farmer.

As we seek efficient train brakes and as the standard set by law is based on the train, it is obvious that terminal brake tests of trains must be made. Stated differently, the requirements can not be met by confining inspecting, testing and repairing to shops and repair tracks. Consideration of overtime and the sixteen-hour law, as well as expeditious train movement demand the minimum lapse of time between that for which the crew is called and the time the train departs. Hence, a train prepared for departure should require no more brake work after the engine is coupled than, at the most, stopping a few leaks in hose couplings and making the formal test. But often there are greater delays due to making other repairs, or the train proceeds with less efficient brakes than it should have. To avoid this, the repairs required must be determined with arriving trains. The incoming engineer should add to the reduction required for stopping enough to fully apply the brakes, and the brake-

* Abstract of a paper read at the December meeting of the Western Railway Club, Chicago.

man should await his advice that this has been done before cutting off the engine. Car inspectors should be present to make an immediate examination and to bad order all defective brakes. Such repairs as ordinary brake pipe leaks, defective hose and wrong piston travel, which require little time, should be made, but cars requiring heavy brake repairs should be marked for the repair tracks.

Here is where judgment must be exercised, as perishable or other very important loads, as well as empties needed at once for such lading, must not be delayed. Neither should other less important cars be held in numbers far greater than the local force can repair in a day if such force is as great as the regular amount of work, including such repairs, would keep busy. The car foreman and the yard master should consult to adjust this, but when the former removes bad order marks without repairs having been made, he should fill out and apply an air brake defect card to better insure prompt repairs at the earliest practicable date. However, it does not follow that the repairing of defective brakes cannot be done without delay to cars which should go forward promptly. The Minneapolis, St. Paul & Sault Ste. Marie has largely solved this problem at an important terminal yard by assigning a short track in the yard for air brake repairs to such cars. With a few men and the necessary repair materials, such cars are often ready for the first train out, are never actually delayed, and few are allowed to go forward without repairs. This is but one detail of a very comprehensive scheme of improvement in freight brake maintenance effected by this road.

As one repair point on a large system cannot maintain all freight car brakes, it is obvious that each terminal should do its share, but this does not mean that other than the outgoing test should be made on through trains at the points with small facilities. A brake well repaired will go for a long period without becoming defective, but the too common failure to do so is due to inadequate repairs. To reduce the cost of brake cleaning by leaving cylinders and auxiliary reservoirs loose on the car is to insure leaky pipes. The same result follows if the brake pipe and retaining valve pipe are not well secured. That most serious fault, brake cylinder leakage, will develop sooner than it should, sometimes immediately after the cleaning, unless a suitable lubricant is employed and packing leathers are replaced when a good inspection and a careful test would show that they should be. The practice often followed of cleaning and testing triple valves on the car cannot insure good work. Neither is it common practice to test hose with soap suds while under maximum pressure and remove those found porous, or to examine the retaining valve weight and clean the case and small vent port. Until these and other details are given better attention in shops and on repair tracks, it will not be possible to effect the economy in time and money in terminal brake testing and the consequent repairs that will otherwise follow.

The M. C. B. requirement that cars in interchange must have retaining valves should imply the maintenance of this part and its pipe by the owning road. It is not sufficient to say that the mountain road may make needed repairs at the owners' expense, as this means undue delay to traffic. However, inspections show that the average efficiency of brakes is otherwise much lower on the cars of level grade roads, a condition for which there is no warrant as that for the average mountain grade road is enough below 100 per cent. efficiency to justify making it the minimum.

That the regular terminal test of freight train brakes misses many of the defects which nullify the object sought in attaching air brakes, is conclusively demonstrated by the following: Within a few months competent parties made a test on several freight trains at the summit of a mountain grade, following a similar test by regular inspectors at the preceding division terminal, and out of which trains bound down this grade were supposed to leave with 100 per cent. efficient brakes, based on such test. The tests consisted of charging to 70 lbs., making a service reduction of 15 lbs.

Per Cent Good Brakes by Test.		Tons per Good Brake by Test.		Cars per Train.
Standing.	Thermal.	Standing.	Thermal.	
97.7	68.8	42.6	59.5	61
91.0	75.0	45.0	54.6	56
100.0	60.0	40.7	67.6	58
98.1	53.7	42.5	77.6	54
98.1	52.8	43.8	81.5	53
96.4	53.5	41.7	75.0	56
88.9	67.2	46.2	61.2	55

and rapidly examining for any brakes failing to apply or leaking off and incorrect piston travel. To show conclusively the oversights of the ordinary terminal brake test the infallible thermal brake test was made on each train at the foot of the grade. The customary plan was there followed of considering three cars with "warm" wheels equal to one with "normal" wheels; that is with a good brake. In addition to showing the results in percentage, they are given in "tons per good brake," derived by dividing the train tonnage by the number of good brakes.

The first train was a test train and had 2,501 tons. The other six were regular trains and ran from 2,252 to 2,367 tons, averaging 2,286 tons. Each train had a considerable percentage of foreign cars. No tests of or repairs to retaining valves were made.

The big returns from good brakes are mainly concealed, consisting of the more expeditious train movement they make possible and the avoidance of accidents, neither of which can ordinarily be shown in dollars and cents. Their observable expenses, consisting of initial cost, maintenance, flat and cracked wheels and delays to cars and trains for brake testing and repairs, are so readily seen and tabulated as to generally render even more obscure their great but intangible credit account. The pressing need is for a more accurate and practical appreciation of the fact that good brake maintenance is economy and for better directed efforts toward improved brake maintenance with a minimum increase in time and money spent. In this the active cooperation of the yard master and the superintendent will aid greatly. Too often their efforts are directed toward showing why trains cannot be held or switching done for brake work, rather than how to accomplish the desired results with the least delay or additional switching.

THE CITY AND SUBURBS PLANS ACT.

The following is the text of the new Act respecting Surveys and Plans of Land in Certain Cities and Their Suburbs, passed by the Legislature of Ontario:

Where any person is desirous of surveying and subdividing into lots with a view to the registration of a plan of the survey and subdivision, any tract of land lying within or within five miles of a city, having a population of not less than 50,000, he shall submit a plan of the proposed survey and subdivision to the Ontario Railway and Municipal Board for its approval.

The Board shall have authority before approving of the proposed plan to require such changes to be made in it as the Board may deem proper as to:—

(a) The number and width of the roads or streets;

(b) The direction in which the roads and streets are to run and their location; and

(c) The size and form of the lots.

Nothing in clause (a) shall authorize the laying out of any road or street, less than 66 feet in width.

In determining as to the suitability of the proposed plan, or as to the desirability of any change in it, the Board where the land lies within the city shall have regard to making the subdivision and roads and streets and their location and width, and the direction in which they are to run, conform as far as practicable with any general plan which has been adopted or approved by the council of the city in accordance with which it is contemplated that the city and suburbs shall be laid out or the re-arrangement of the streets and thoroughfares shall be effected, and where the land is situate without the limits of the city, the Board shall have regard to

(a) The proximity of the land to the city;

(b) The probability of the limits of the city being extended so as to include it;

(c) The securing of driveways and adequate thoroughfares connecting the city and the outlying districts;

(d) Making the subdivision and the roads and streets and their location, and width, and the direction in which they are to run, conform as far as practicable with any plan so adopted or approved or if no such plan has been adopted or approved with the plan on which that part of the city which lies nearest to the land is laid out.

No plan of any such land shall be registered unless it has been approved by the Board and a certificate of its approval, signed by the chairman or a member of the Board or the secretary is endorsed on the plan, and no lot laid down on a plan, not so approved shall be sold or conveyed by a description containing any reference to the lot as so laid down or to such plan.

Notice of an application to the Board for its approval of a plan, shall be given to the corporation of the municipality in which the land is situate and to the corporation of the city, and all parties interested shall be entitled to be heard, and maybe represented by counsel at the hearing of the application.

A copy of the plan shall accompany such notice.

Objections to the plan shall be stated in writing and be filed with the secretary of the Board within 21 days after delivery of the notice and plan.

If no objection is made within that period the applicant shall be entitled to have the plan certified as approved, unless the Board of its own motion shall have otherwise directed.

Sittings of the Board shall, if required by the council or municipality objecting to the plan, take place at such time and place in the city nearest to the land, as the Board, by notice to the applicant and to the clerk of the municipality requesting the same, appoints.

ENGINEERING NOTES.

Province of Ontario.—Under the provision of the Public Health Act, the Provincial Government will organize seven health districts. Two of these will be in New Ontario, two in the sparsely settled districts stretching across from Georgian Bay to the Ottawa River, and the remainder so arranged as to produce the best results, having regard to population and natural conditions. This will mean in all fourteen salaried appointments—seven district health officers and seven inspectors, the former to receive a salary of $2,500 per year, the latter $1,000. These districts will be so arranged as not to conflict with the work of the municipal health bodies now working in towns and cities that are not part of counties, and the organization will be made effective as soon as the present officials serve out their terms of office.

Mr. J. B. Shelton, car foreman of the Grand Trunk Pacific shops at Transcona, Man., is building a new truck and sleeping-car for the use of employees when called to wrecks. The car will be a model of its kind, and will materially add to the comfort of the men.

PERSONAL.

Mr. F. B. Connery has resigned from his position as superintendent of overhead construction work with the Toronto Hydro-Electric Commission and has accepted a similar position with the Toronto Power Company.

Mr. Jackson Clark, of Wellington, Ont., has received the appointment of assistant district provincial surveyor and will be located at North Battleford, Saskatchewan. Mr. Clark graduated from the School of Practical Science this year.

Mr. Alan Mair Jackson, who has just passed his final O.L.S. examination, has been appointed county engineer for Haldimand county, with headquarters at Dunnville, Ont. Mr. Jackson is an associate member of the Institute of Mining and Metallurgy.

OBITUARY.

Charles Robert Boucher, one of the most widely known railroad engineers in Canada, died at Sault Ste. Marie, Ont., on April 26th last. Up to the time of his illness he had been engaged in building bridges along the line of the Algoma Central Railway. He was also prominent in the construction of the Temiskaming and Northern Ontario, and had been from coast to coast on both sides of the border in railroad construction. He was buried in New York. He leaves a widow and one son. He was 64 years of age.

BOARD OF GOVERNORS OF THE UNIVERSITY OF TORONTO.

Mr. T. A. Russell and Lieut.-Col. Albert E. Gooderham were appointed by the Provincial Government on April 25th to places on the Board of Governors of the University of Toronto. These gentlemen are to take the places formerly occupied by Hon. W. T. White and Hon. T. W. Crothers. The appointments take effect at once.

NEW PRESIDENT OF AMERICAN ELECTRO-CHEMICAL SOCIETY.

Mr. William Lash Miller, professor of chemistry at the University of Toronto, has been elected president of the American Electro-chemical Society.

To a Canadian this is a signal honor, in view of the fact that he will represent the American Electro-chemical Society at the Congress of Applied Chemistry, which meets in Washington next September on the invitation of the President and Government of the United States.

At the meeting of the Congress, which is held every five years, will be industrial chemists from all over the world. This will be the first time the society has met in America. The last meeting was in Rome.

ANNUAL MEETING SOCIETY OF CHEMICAL INDUSTRY.

The Society of Chemical Industry elected the following officers at the annual meeting held April 25th, Toronto: Chairman, Wallace P. Cohoe; vice-chairman, R. F. Ruttan, W. L. Goodwin and Prof. J. Watson Bain; Executive Committee, H. P. Mills, O. H. Wurster, R. T. Mohan of Hamilton, A. Neighorn, Milton L. Hersey, C. F. Heebner, J. A. De Cew, Prof. W. Lash Miller, G. F. Guttman, N. N. Evans, T. H. Wardleworth, E. G. R. Ardagh.

Mr. O. H. Wurster read a paper on the manufacture of glycerine as a by-product of soap. He showed the various methods used commercially, and which may be used in the future for the refining of the crude glycerine so produced in order that the glycerine may be used in the manufacture of dynamite, and also to produce a chemically pure glycerine for other purposes.

Mr. Anthony McGill, LL.D., of the Inland Revenue Department, Ottawa, presided.

COMING MEETINGS.

CANADIAN INSTITUTE.—198 College Street, Toronto. May 4th—Annual Meeting and Election of Officers. President, J. B. Tyrrell; Secretaay, Mr. J. Patterson.

AMERICAN RAILWAY ASSOCIATION.—May 15th, Semi-Annual meetlng at New York City. Sec'y, W. F. Allen, 75 Church St., New York.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—May 22nd-25th. Annual Convention at Chicago, Ill. Secy., D. B. Sebastian, La Salle St. station, Chicago.

FOURTH NATIONAL CONFERENCE ON CITY PLANNING.—May 27th-29th. Meeting, Public Library, Boston, Mass. Sec'y, Flavel Shurtleff, 19 Congress Street, Boston, Mass.

AMERICAN WATER WORKS ASSOCIATION.—June 3rd-8th. Annual Convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N.Y.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithica, N.Y.

ONTARIO MUNICIPAL ASSOCIATION —Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION —President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President, J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
4-30	Tunnel sewer, Edmonton, Alta. .....(S.)	4-4
4-30	Trunk sewer, Edmonton, Alta. .....(S.)	4-11
4-30	Subway, Moose Jaw, Sask. .....(P. & S.)	4-18
5-10	One diesel oil engine, Vernon, B.C. .....(S.)	4-25
5-15	Reinforced arch bridge, Guelph, Ont...(P. & S.)	5-2
5-29	—Water works, sewerage and electric light systems, Melfort, Sask. .....(P. & S.)	5-2

(Saskatoon plans and specifications are on file at The Canadian Engineer Office, 820 Union Bank Building, Winnipeg).

(Melfort plans and specifications are also on file at The Canadian Engineer Offices, 820 Union Bank Building, Winnipeg, and B33, Board of Trade Building, Montreal).

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Arborg, Man., school house ....May 1.		Apr. 11.	59
Berlin, Ont., sewer pipe .....May 1.		Apr. 25.	61
Calgary, Alta., timber structures May 15.		Apr. 18.	76
Calgary, Alta., concrete structures .....May 1.		Mar. 28.	70
Calgary, Alta., designs for aqueduct .....May 1.		Feb. 22.	70
Exeter, Ont., water pipes, etc...May 6.		Apr. 25.	72
Exeter, Ont., sewer pipe .....May 10.		Apr. 25.	72
Fort William, Ont., garbage incinerator .....May 15.		Apr. 18.	74
Fredericton, N.B., school building, St. Mary's Reserve ...May 2.		Apr. 18.	60
Guelph, Ont., laying tracks ....May 3.		Apr. 25.	72
Hillsborough, N.B., post office fittings .....May 6.		Apr. 25.	62
Lebret, Sask., school house...May 31.		Apr. 25.	61
Little Pines, Sask., school house, etc. .....May. 6.		Apr. 4.	60
Moose Jaw, Sask., paving ....May 15.		Apr. 25.	72
Muncey, Ont., alterations to Industrial School .....May. 1.		Apr. 4.	60
Orangeville, Ont., bridge .....May 6.		Apr. 25.	61
Ottawa, Ont., pumping machinery .....May 14.		Apr. 25.	70
Ottawa, Ont., dredging .....May 6.		Apr. 25.	62
Ottawa, Ont., road machinery ..May 6.		Apr. 25.	62
Ottawa, Ont., dredging .....May 13.		Apr. 25.	62
Ottawa, Ont., steel tug .....Apr. 22.		Apr. 11.	60
Ottawa Ont., designs for monument .....Oct. 1.		Apr. 18.	60
Ottawa, Ont., fishing protection vessel .....June 17.		Apr. 18.	74
Port of Quebec, Que., proposals for drydock .....July 2.		Apr. 18.	60
Point Grey, B.C., plans for university .....July 31.		Feb. 7.	60
Regina, Sask., electric supplies, Sec. 6 to 9 .....May 15.		Apr. 11.	72
Saskatoon, Sask., superstructure 23rd Street subway .....May 17.		Apr. 18.	76
Sault Ste. Marie, Ont., widening lower entrance channelway .....May 10.		Apr. 18.	60
Selkirk, Man., bridge, Gunn's Creek .....May 7.		Apr. 18.	60
Stratford, Ont., bank building..May 6.		Apr. 25.	62
Toronto, Ont., Dundas Street ..May 7.		Apr. 25.	72
Vancouver, B.C., pumping engine, hose wagon, etc. ....May 2.		Apr. 11.	60
Vancouver, B.C., water pipe and gate valves .....May 15.		Apr. 25.	62
Varna, Ont., drainage work ..May 15.		Apr. 25.	62
Vernon, B.C., diesel oil engine.May 10.		Apr. 25.	72

TENDERS.

Arkona, Ont.—Tenders for the erection of the Arkona Baptist Church, plans and specifications of which may be seen by applying to W. J. George, Arkona, will be received by the Secretary, R. Crawford, up to May 10th, 1912.

Cobourg, Ont.—Tenders will be received till the 14th day of May, 1912, for the construction of sewage disposal works for the House of Refuge, Cobourg. Specifications, etc., at the office of the Engineer, T. Aird Murray, 303 Lumsden Building, Toronto, or at the Town Hall, Cobourg. (See advt. in Canadian Engineer).

Guelph, Ont.—Whole or separate tenders addressed to Prof. W. H. Day, O. A. College, will be received up to noon of May 8th, 1912, for the several trades in connection with the erection of a Masonic Temple, Guelph. Plans and specifications may be seen at the office of W. A. Mahoney, Architect, 20 Douglas St.

Grandview, Man.—Tenders for the construction during 1912 of about 30,000 feet of granolithic sidewalk in the town of Grandview, Man., will be received by Wm. Dickie, Secretary-Treasurer, Grandview.

Guelph, Ont.—Tenders for the construction of a reinforced arch bridge and viaduct for foot traffic on Heffernan Street, over the C.P. Railway and the River Speed, having a total length of about 520 feet. J. Hutcheon, city engineer. (See advt. in Canadian Engineer.)

Hamilton, Ont.—Tenders will be received up to Thursday, May 30th, 1912, for supplying the corporation of the city of Hamilton with flanged special castings for Beach Pumping Station, 3 Venturi meters, 2 travelling cranes, and water tower. Specifications at the office of the City Engineer. S. H. Kent, City Clerk. (See advt. in Canadian Engineer).

Hamilton, Ont.—Tenders will be received by Geo. H. Lees, Mayor, up to May 9th, 1912, for the several works required in the erection of a public comfort station under Hughson Street roadway. Plans, etc., at the office of the architect, A. W. Peene, No. 2 King Street West, 2nd floor, Hamilton. S. H. Kent, City Clerk, Hamilton.

Kamloops, B.C.—Tenders are invited for the supply of all materials and labor required for the completion of a new High School at Kamloops, B.C. Plans and specifications may be seen at the office of John Parlett, architect, Freemont Block, Victoria Street, Kamloops.

London, Ont.—Tenders for fifteen bridges to be erected in London Township will be received by Mary Grant, clerk, 110 Dundas Street, London, until noon of May 4th, 1912. Plans and specifications at the County Engineer's office, County Buildings, city.

Melfort, Sask.—Tenders will be received until May 29th, 1912, for water works, sewerage and electric light systems for the town of Melfort. J. E. Durin, secretary-treasurer, Melfort, Sask. Messrs. McArthur, Murphy and Underwood, engineers. Bottomley Block, Saskatoon, Sask. (See advt. in Canadian Engineer.)

Province of New Brunswick.—The Department of Public Works, Fredericton, will receive tenders for the rebuilding of Lane's Creek arch bridge culvert at Upper Woodstock, Carleton County. The tenders are to be in by May 20th next.

North Battleford, Sask.—Tenders will be received by the Secretary-Treasurer until 8 p.m., on the dates specified against the respective works, for the following, viz.:—

Contract H, furnishing and erecting boiler, May 15th.

Contract J, furnishing and erecting 750 horse-power steam engine and accessories, May 15th.

Contract K, furnishing and erecting 500 k.w. generator and equipment, May 15th.

Plans and specifications may be seen at the office of the engineers, Toronto and Winnipeg, and at the town hall, North Battleford. J. Griese, Esq., Mayor. H. W. Dixon, Secretary-Treasurer. Chipman & Power, Engineers.

Ottawa, Ont.—Tenders for the construction of a Public Building at Wallaceburg, Ont., will be received at the Department of Public Works, Ottawa, up to 4 p.m., on Wednesday, May 13th, 1912. Plans, etc., at the Post Office, London, Ont.; Post Office, Wallaceburg, Ont., and at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—The Department of Trade & Commerce has been advised that the Commonwealth of Australia is inviting tenders for 135,633 tons of steel rails and 9,644 tons of fish plates required for the government railway system. Tenders close on May 29th. Canadian manufacturers will forward offers by mail which leaves San Francisco on May 1st. Rails and fish plates are to be of open hearth steel, and are to be delivered at Fremantle and Port Augusta. The rails are to be 80 pounds to the yard mostly, but a small portion is to be 60 pound rails.

Ottawa, Ont.—Tenders will be received by the secretary, R. C. Desrochers, Dept. of Public Works, until May 13th, 1912, for dredging required at the following places in the province of Ontario: Goderich, Napanee, Picton, Telegraph and Nigger Islands.

Ottawa, Ont.—Tenders will be received by the secretary, R. C. Desrochers, Dept. of Public Works, Ottawa, up to May 15th, 1912, for dredging required at the following places in the province of Ontario: Lanoraie, Woodland, Vercheres, Varennes and Lavaltrie. Specifications, etc., at the office of the Dept. of Public Works, Ottawa.

Owen Sound, Ont.—Tenders for a concrete dam at Inglis Falls will be received up to noon, Monday, May 13th, 1912, at the office of the Wm. Kennedy & Sons, Ltd., Owen Sound, at which place plans and specifications are to be seen.

Owen Sound, Ont.—Tenders will be received up to noon of May 9th, 1912, for all trades required in the erection of a Public Library Building at Owen Sound. Drawings, etc., may be obtained at the Architects, Forster & Clark's office. J. H. Packham, Chairman of the Board.

Regina, Sask. — Tenders will be received by the City Commissioners up to noon of May 5th, 1912, for the construction of two filter beds, one stand-by tank, pipe lines connecting with the various parts of the works. Copies of plans and specifications may be had from J. M. MacKay, chief engineer, trunk sewer works, Regina.

Saskatoon, Sask.—Tenders will be received by the City Commissioners up to noon of Tuesday, June 25th, 1912, for the complete installation (including all buildings) of a 70 ton per 24 hours incinerator plant, and the operation of the same for a period of three months after completion. (See advt. elsewhere in Canadian Engineer.)

Toronto, Ont.—Tenders will be received up to noon, Monday, May 6th, for the dredging of the crib berths at the new Ashbridge's Bay docks. Plans of location, etc., may be obtained at the office of the Toronto Harbor Commissioners, 76 Adelaide Street West. F. S. Spence, Acting Chairman.

Weyburn, Sask.—The Secretary, Weyburn High School, will receive tenders up to Friday, May 10th, for the erection of a Collegiate Institute building. Copies of plans and specifications may be seen at the office of Geo. J. G. Jarrett, architect, Weyburn, and at the Builders' Exchange in Regina and Winnipeg.

Winnipeg, Man.—Tenders, separate, will be received by the Chairman, Board of Control, up to noon of May 15th, 1912, for the manufacture and delivery at the city gravel pit, Bird's Holl, Man., of one electric locomotive with accessories complete, and one electrically-operated shovel with accessories complete. Specifications, etc., may be obtained at the office of the City Light and Power Department, 54 King Street. M. Peterson, Secretary, Board of Control Office, Winnipeg.

CONTRACTS AWARDED.

Battleford, Sask.—The Western Pavers, Limited, Saskatoon, have the contract for laying approximately 150,000 sq. ft. of cement sidewalk, with crossings and curbing.

Brandon, Man.—The work of construction on the two wings of the new asylum will be carried out by Mr. John Clark, who also has the contract for the main building, which will soon be completed. The addition will be the same height as the rest of the new building, and will cost over $100,000.

Fredericton, N.B.—The Fredericton & Grand Lake Coal & Railway Company have signed a contract with Messrs. A. E. Trites & Son for the construction of the Gibson and Minto Railway. The contract calls for the construction of the road between Gibson and Minto, a distance of 31 miles, and also for the construction of the masonry structures of the several bridges on the line. The Dominion Bridge Company of Montreal will have the contract for the superstructures of the bridges. The cost of the railway, including bridges, will be $650,000.

Kenora, Ont.—The contract for the installation of the new electrical unit in the power-house has been awarded to Messrs. Allis-Chalmers-Bullock Company of Montreal. The contract amounts to $25,000.

Lake Quinze, Maple Rapids, Que.—Dam and sluiceways, contractors, Messrs. Morrow and Beatty, of Peterborough, Ontario.

Little Lameque, N.B.—Wharf: Contractor, H. G. Beresford, of St. John, N.B.

Moose Jaw, Sask.—The contract for laying about 96,000 lineal feet of 18-inch steel water pipe has been awarded, one-half to Maurice S. Holmes, Souris, Man., at 90c. per lineal foot complete, and the other half to the Moose Jaw Construction Company, Limited, at 94c. per lineal foot complete. Walter J. Francis and Company, Consulting Engineers.

Moose Jaw, Sask.—The Moose Jaw Construction Company, Limited, have received contract for supplying and erecting a reinforced concrete reservoir of 2,000,000 gallons capacity at a cost of $34,352. Walter J. Francis and Company, Consulting Engineers.

Moose Jaw, Sask.—The contract for supplying and erecting four centrifugal pumps, two motors, wiring, switchboard and accessories, has been awarded to The Canadian Boving Company, Limited, 164 Bay Street, Toronto. Price, $4,075. Walter J. Francis and Company, Consulting Engineers.

Moose Jaw, Sask.—Contracts for supplying and erecting two prime mover equipments, transmission equipment and accessories for headworks pumping station at Caron, have been awarded to the Canadian Fairbanks-Morse Co., Ltd., of Montreal, their price being $8,755.

Moose Jaw, Sask.—Supply of various valves and fittings for waterworks installation: Contractors, Messrs. Drummond, McColl & Co., Montreal, Que., unit prices total amounts to about $8,000.

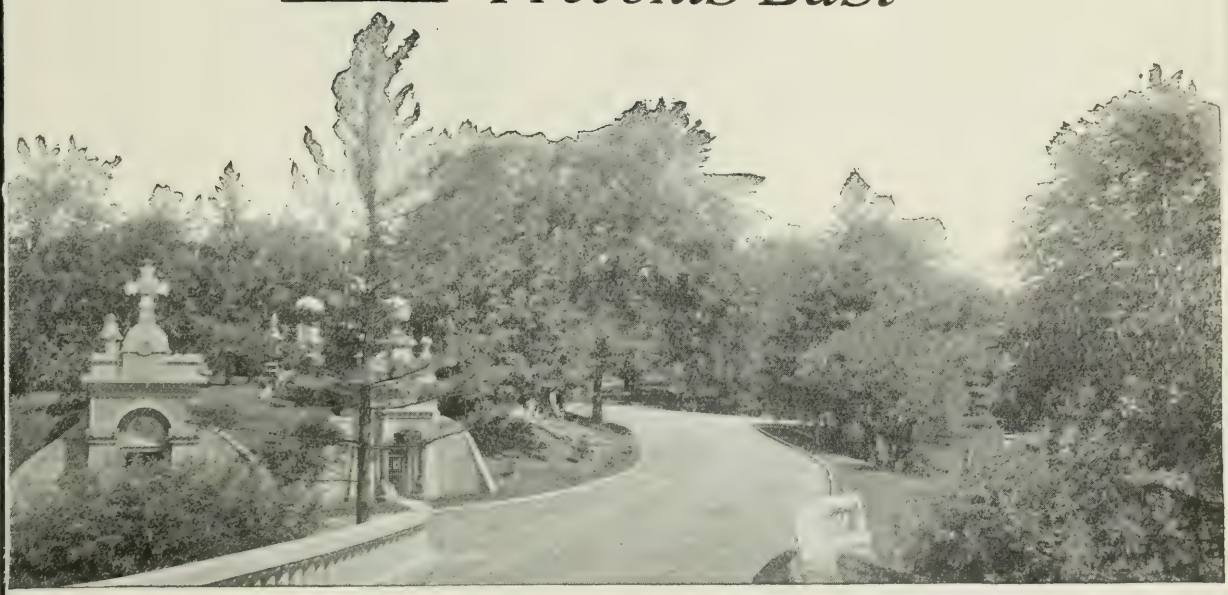
Moose Jaw, Sask.—The contract for supplying and erecting one elevated water tank of 75,000 gallons' capacity, has been awarded to George T. Horton, Washington Heights Station, Chicago, Ill., at a cost of $6,400.

Moose Jaw, Sask.—The following tenders were received for the extensions that are to be made to the King Edward Schools: The Western Building Company, $30,972; Gowan & Potts, $32,950; and Navin Bros., $31,500. The Western Building Company received the contract, which includes heating and all other necessaries.

Moose Jaw, Sask.—Contract for the supply and delivery of sewer pipe and specials f.o.b. cars, Moose Jaw, has been awarded to the Dominion Sewer Pipe Co., Swansea; price, $5,117.85. Other bidders were: The Ontario Sewer Pipe Co., Mimico, $5,500; Messrs. Whitlock & Marlatt, Moose Jaw, $5,555; Saskatchewan Glass & Supply Co., city, $5,659.75; Astrid S. Paving Co., Chicago, $5,677.50; Toronto Pottery Co., $5,865.50.

Tarvia

Preserves Roads
Prevents Dust~



Mount Pleasant Cemetery, Toronto. Roads built with Tarvia X in 1909.

Two Years' Trial in Toronto

THE above roadway in Mount Pleasant Cemetery, Toronto, was built with "Tarvia X" in 1909. The photograph was taken in the fall of 1911 and gives a fair idea of the excellent condition of this road, after two years of travel.

In the background this road has a five per cent. grade and if ordinary macadam had been used the surface would be raveled and worn out long ago. The best demonstration of the success of Tarvia is that the Cemetery authorities, after two years, are going to use a great deal more of it, as the following letter from the Superintendent shows:

February 15th, 1912.

Dear Sirs:

I wish to let you know we will require "Tarvia X" to build about 6500 yds. of road this year about the end of July.

I may say that we are well pleased with our Tarvia roads. The first that were made in 1909 have stood the test of traffic and heavy loads up to 16 tons—the wagon wheels leaving no impression.

Where our roads have a 7% grade we find the Tarvia fills the bill; no washing, no dust, easy to sweep and clean in wet weather.

(Signed) W. H. FOORD, Supt.

Tarvia is a dense, viscid tar product of great adhesive power. When built into the road as a binder, it forms a matrix about the stone, keeps the stone in position and furnishes an element of plasticity which greatly prolongs the life of the macadam under heavy loads or automobile traffic. There are three grades for different types and conditions of roads.

Booklets regarding same free on request.

The Paterson Manufacturing Co., Limited

MONTREAL TORONTO WINNIPEG VANCOUVER

The Carritte-Paterson Manufacturing Co., Limited

ST. JOHN, N.B. HALIFAX, N.S.

North Battleford, Sask.—Messrs. Kilbride, Kilbride & Sutherland, of North Battleford and Calgary, have received the contract for 180,000 sq. ft. of concrete sidewalk. Price, 10-ft. walk, 18c.; 6-ft., 5-ft., and 4-ft. walk, 15c.

Port Arthur, Ont.—The Northern Electric & Manufacturing Co. have been awarded the contract for the installation of a fire alarm system at a cost of $10,343.

Prince Albert, Sask.—The Ambursen Hydraulic Construction Co. of Montreal, has been awarded the contract for the construction work on the proposed Lacolle Falls power scheme. The estimated cost of the whole undertaking totals up to $945,000.

Regina, Sask.—Contracts for trunk sewer pipe have been awarded by the city council as follows:—

1.—Seventh Avenue Trunk Sewer, the Canadian Lock Joint Pipe Company, $41,133.70.

2.—Wascana Valley Trunk Sewer Contract No. 1, the American Sewer Pipe Company, $29,631.04.

3.—Wascana Trunk Sewer Contract No. 2, Messrs. Broley & Dicken, of Fernie, B.C., $20,585.20.

Toronto, Ont.—Dredging of Approach Channel to Ferry Wharves at Hanlan's Point, in Toronto Bay: Contractors, the General Construction & Dredging Co., Ltd., of Toronto.

Upper Salmon River, N.B.—Pier: Contractors, Warren Downey and Oscar Downey, of Curryville, N.B.

Victoria, B.C.—The British-American Construction Company have been awarded contracts for the construction of the piers, landing stage, building platform and launching ways in connection with the construction of the G.T.P. drydock at Prince Rupert.

Victoria, B.C.—The contract for the work on the new High School on the site at Fernwood Road, has been awarded to Messrs. Dinsdale & Malcolm. The building is to cost about $329,000.

Winnipeg, Man.—The Burridge-Cooper Company, Limited, of Winnipeg, have the contract for supplying a 50-h.p. gasoline traction engine, delivered f.o.b. city yards at $3,350.

Winnipeg, Man.—Supply of ten double end asphalt wagons, to be delivered f.o.b. cars, city yards; contractors, Messrs. Burridge-Cooper Co., Ltd., Winnipeg; cost, $3,440.

Winnipeg, Man.—Engineer of Construction, J. W. Astley, Winnipeg, has the contract for the erection of a machine shop at city yards, Ross Avenue and Tecumseh Street, at a cost of $16,568.

Winnipeg, Man.—The firm of Barrett & McQueen, contractors, were awarded the contract by the C.P.R. for the erection of a million-bushel transfer elevator in the company's new yards in North Transcona.

RAILWAYS—STEAM AND ELECTRIC.

Calgary, Alta.—A report states that within a month or two work will be started on the building of a railway to the property of the Alberta and Canada Iron Syndicates, 25 miles west of the town of Okotoks, and when the railway is completed, a great smelter and a 400 ton stamp mill will be erected and iron will be mined. The whole project will involve the expenditure of around $5,000,000. P. Burns is behind the venture.

Province of British Columbia.—Messrs. Mackenzie and Mann have purchased the Butte Inlet Railway Charter in this province. It is reported that they will construct about twenty miles of the line during the coming season.

Eastern Ontario.—The Canadian Pacific Railway have recently installed a new block signal system on their lines between Hull and Ottawa. According to the system a train cannot leave Hull or Ottawa before the conductor has obtained a staff which is locked and unlocked by electrical means. Only by deliberately ignoring the system could a collision of two trains occur between Hull and Ottawa.

Province of New Brunswick.—Contracts are being closed for the construction of Gibson and Minto Railway during the season now opening.

Sir Thomas Tait, as president of the Fredericton and Grand Lake Coal and Railway Company, is signing the contract with the Provincial Government, and the work has been offered to Messrs. A. E. Trites & Son, and will be, it is expected, accepted by them.

Northern Ontario.—The T. & N. O. Commissioners have placed an order for a gas-electric car according to a recent report.

Welland, Ont.—A deputation of farmers, fruit-growers and business men from Pelham and Font Hill were promised consideration of their request for line extension from the management of Niagara, St. Catharines and Toronto Electric Railway.

Western Canada.—Revision of existing grades and surveys for double tracking the Canadian Pacific main line between Vancouver and Calgary, a distance of over 600 miles, are now under way. The work is in charge of F. F. Busteed, former general superintendent of the British Columbia division, who has established headquarters at Kamloops, B.C.

LIGHT, HEAT AND POWER.

Prince Albert, Sask.—Mr. J. R. Heckle, representing the Ambursen Hydraulic Construction Company, has made a proposition to the municipal council of this city regarding the construction of a dam and headworks for the Lacolle Falls power scheme.

Province of Quebec.—A notice has been sent out from the department dealing with the provincial water powers to the effect that the proposed auction of water powers in this province arranged to be held on May 14th next has been postponed until June 26th by order of the Minister of Lands and Forests.

Winnipeg, Man.—Considerable activity will soon be witnessed in the matter of line construction in and around this city owing to the department having charge of the civic light and power calling tenders for 2,000 wooden poles.

GARBAGE, SEWAGE AND WATER.

Cartierville, P.Q.—A sterilization system depending on hypochlorite of calcium has been installed in this municipality under the supervision of Engineer Meadows, of the Provincial Board of Health. The system has given satisfactory service so far.

Toronto, Ont.—The cost of constructing the filtration plant at the Island has amounted to $40,000 above the original estimates. The additional expense is made up as follows:—Changes in the electrical equipment at the pumping station and the installation of the Island pumping plant at the station, $9,000; extra fill for the clear water reservoir, $3,500; additional motors, $2,000, and the balance in miscellaneous work.

Winnipeg, Man.—Owing to an accident at the pumping plant at the main city well the city was recently on the verge of a water famine, as a supply of 5,000,000 gallons of the 7,500,000 gallons is expected from this source.

BUILDINGS AND INDUSTRIAL WORKS.

Calgary, Alta.—Negotiations that have been under way for some time have been concluded and as a result the Winona Pioneer Tractor Company will erect a large plant in this city.

Edmonton, Alta.—Work will commence on a new Grand Trunk Pacific hotel at Edmonton, Alberta, which will be a third link in the chain of hotels which this company intends to build throughout Western Canada. For some time Messrs. Ross & McFarlane, architects, of Montreal and Winnipeg, have been engaged in the preparation of plans, and within a few weeks the actual construction work will begin.

Edmonton, Alta.—The directors of the Alberts College have purchased 240 acres and are about to erect a modern educational institution for boys and young men.

Fort William, Ont.—The Edwardsburg Starch Company, propose the erection of a starch and syrup factory to cost $350,000.

Hamilton, Ont.—Mr. M. S. Glassco and G. B. Jacobs are looking for a suitable site on which to erect a jam factory. The capital of the new concern is given as $100,000.

Medicine Hat, Alta.—Messrs. Bennett and Lockwood are about to erect a new hotel on Montreal Street, and W. R.

48 in. CONTINUOUS STAVE LINE.

Manufacturer of

Galvanized Wire Machine Banded

WOOD STAVE PIPE

CONTINUOUS STAVE PIPE

RESERVOIR TANKS

For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

Full particulars and estimates furnished.

PACIFIC COAST PIPE COMPANY, LTD.

Factory: 1551 Granville Street, VANCOUVER, B.C. P.O. Box 563.

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EASILY MOVED FROM JOB TO JOB

Test after test has proved that they mean

Low cost of maintenance, along with capacity, strength, and durability.

Demonstrations daily, in all our branches and warerooms.

Write for 1912 Catalogues.

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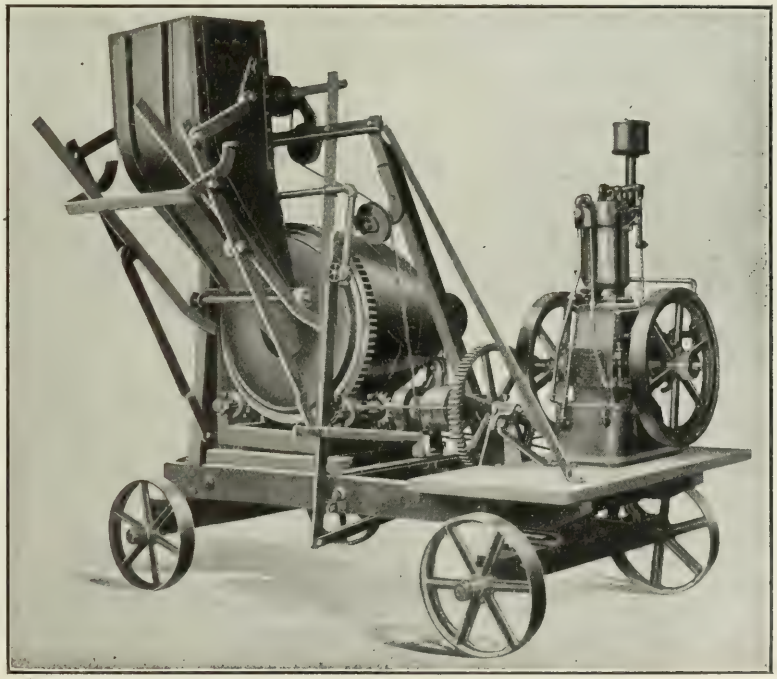

Semi-steel castings used throughout entire construction.

New automatic power dumping and new loading device, means one man operates entire machine, which gives you greater capacity, with reduced labor.

St. John, N.B.:
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Penland has commenced construction work on a new hotel on Ottawa Street. Both are three storey structures.

Nelson, B.C.—The Provincial Government will give the sum of $50,000 toward the erection of a new hospital to cost about $100,000.

North Winnipeg, Man.—The members of the Board of North Winnipeg Hospital are planning to erect a $100,000 structure that will form the nucleus of a modern hospital equipment.

Ottawa, Ont.—The management of the Capital Brewing Company are preparing to erect a new building on Wellington Street. Mr. Kuntz is manager of this company.

Port Arthur, Ont.—Preliminary arrangements are being made for the erection of an I.O.O.F. Hall on the corner of Park and Court St. Estimated cost $40,000.

Regina, Sask.—The management of the Ontario and Manitoba Milling Company have reached a satisfactory agreement with the Board of Trade whereby the company will erect a large milling plant in this city. The company have agreed to erect a mill with an output of 2,000 barrels per day, to erect a linseed flax mill and an oatmeal mill, and to erect their own power plant.

Regina, Sask.—The names of Peter Henry Van Gorp, Iowa, U.S.A., and Anson Barker, of this city, appear on the list of directors of a recently formed agricultural implement manufacturing concern. The company has a capital of $100,000, and it is expected that a building will be erected here at an early date.

Saskatoon, Sask.—The congregation of Grace Church are collecting funds for the erection of their new church. The estimated cost of this work is given at $75,000. Mr. A. C. McEwan is chairman of the committee in charge of the matter.

Toronto, Ont.—Messrs. McGregor & McIntyre are preparing to construct a steel plant on Shaw Street. This work is to cost about $40,000.

Vancouver, B.C.—Plans are under preparation for a $600,000 opera house. The building will be of steel frame construction and have accommodation for 1,550 patrons.

Vancouver, B.C.—The directors of the Vancouver General Hospital have made arrangements for the construction of a laundry addition to the buildings. The cost of this will be about $52,000.

West Toronto, Ont.—Work on a large locomotive roundhouse has been started for the Canadian Pacific Railway. When completed it will accommodate 150 engines.

Yorkton, Sask.—The management of the Hudson Bay Company at Winnipeg will erect a $50,000 store in this town.

Yorkton, Sask.—Mr. W. D. Dunlop will erect a $50,000 store in this city. It is to be red brick and cut stone 60 x 70.

BRIDGES, ROADS AND PAVEMENTS.

County of Chateauguay, P.Q.—The councilmen of this county are preparing to start an extensive programme of road improvement. About $350,000 is to be spent in this work.

Fort William, Ont.—The Island side of the new Canadian Pacific Railway bridge across the Kaministiquia River was badly damaged from the effects of a severe wind storm that swept that vicinity recently. Three approach spans were wrecked and considerable steel work torn from the concrete anchorage.

Hamilton, Ont.—Certain interests in this city are interested in a proposition calling for the paving of the highway between Toronto and Hamilton. They have estimated the cost to be $15,000 per mile, and point out that the many advantages arising from the work would be ample to offset the original outlay.

Lindsay, Ont.—It is reported that a new bridge will have to be constructed over the Pigeon River in the immediate future, as the old one was damaged by ice.

Montreal East, P.Q.—The municipal council of this town are arranging for considerable concrete paving to be done this year.

Peterborough, Ont.—The ratepayers will vote and decide the question of erecting a bridge across the Otanabee River.

Saskatoon, Sask.—The municipal engineering department are about to commence sand stone paving on the steep portions of the city around the Nutana Hills. This work will cost about $15,000.

Vancouver, B.C.—The municipal council have passed an order calling for $500,000 worth of street pavements to be laid during the next few months.

Victoria, B.C.—A delegation has been appointed to present a list of benefits arising out of the construction of a bridge across Seymour Narrows to the Federal Government at Ottawa.

Winnipeg, Man.—Plans are under preparation for the construction of a new steel bridge leading into Elm Park. The plans show a structure 521 feet long with an elevation of 25 feet above the average summer water level. As soon as the plans are ratified at Ottawa tenders will be called. The designer of the bridge is Prof. Brydon Jack, engineer of the Elm Park Company.

FIRES.

Winnipeg, Man.—The Macpherson Fruit Company's plant and storehouse was recently damaged by fire.

Winnipeg, Man.—Fire damaged the plant and premises of Messrs. Brown and Rutherford, lumber merchants. The loss will be about $25,000.

CURRENT NEWS.

Amherst, N.S.—An order for 60,000 tons of car building material has been placed with the mills of the United States Steel Corporation by the Canadian Car and Foundry Co.

This will be used in the construction of a large number of cars recently ordered from the Canadian company by the Canadian Pacific, the Grand Trunk, the Intercolonial and the Canadian Northern.

The Canadian roads are still figuring on further large equipment purchases.

Mr. George J. Bury, vice-president and general manager of the C.P.R. western division, has announced that the company has decided to increase the rolling stock to the extent of $22,000,000 to keep up with the tremendous growth of the system.

Eastern Ontario.—The Dominion Government will probably deepen the Murray Canal from Trenton to Cobourg. It is now nine feet deep and covers a length of eight miles. Survey parties are being sent out, and on their report will depend the extent of the deepening. The canal will be lighted for night navigation this summer.

Fort William, Ont.—The management of the Rhodes-Curry Company of Amherst, N.S., and the management of Edwardsburg Starch Works have been in this city looking for suitable sites on which to establish plants.

Fort William, Ont.—Should the ratepayers vote in favor of granting certain privileges to the management of the Canada Car and Foundry Company, of Amherst, N.S., the company have pledged themselves to erect a plant to cost $1,000,000, to complete the work within 30 months of the start of building operations and employ 1,000 men for the first five years.

Fort William, Ont.—The harbor tug Sarnia is now in dry dock and will have a new set of boilers installed as the old ones were condemned by the Government inspector.

Medicine Hat, Alta.—In order that the Ogilvie Milling Company's plant may be constructed with all possible speed the councilmen have had lists prepared and will request all voters to attach their names and their method of voting. In this way the delay caused by the preparation of the voters list will be overcome and should the majority pledge their support for the by-law the company will commence building operations at once.

Moncton, N.B.—A company has been recently formed in this province to work and develop the tungsten deposits. The capital stock of the concern is given as $60,000, and Mr. Samuel Freeze, Moncton, N.B., has been elected vice-president and manager. The purposes of the company are to explore the tungsten and tin ores discovered at Burnt Hill Brook on the Miramichi River, which in a measure was opened up

Announcement of the Standard Underground Cable Co., of Canada, Ltd.

Canada's New Industry

On or about May 15th, 1912 our new plant at Hamilton, Ontario, will start operation. Our Bare Wire Department will be ready to meet your requirements on that date and other departments will be started as rapidly as possible. Within three months from the above date we expect to have the complete plant running and able to meet, promptly and satisfactorily, your every requirement for the following materials:

"Standard" Products

Copper Rods
Bare Wire and Cable
Standard C.C.C. Wire
(Colonial Copper Clad)
Magnet Wire
Weatherproof Wire and Cable
Rubber Braided Wire and Cable
Varnish Cloth (Cambric) Cable
Fibre Insulated Leaded Cable
Dry Paper Leaded Cable
Saturated Paper Leaded Cable
Rubber Lead Covered Cable
Armored Cable
Terminals and Junction Boxes
Splicing Tubes and Compounds
Insulating Tapes and Varnishes
Cable Hangers, Supports, etc.

Cable Systems Installed Complete.

The rapid growth of the Canadian business of the Standard Underground Cable Co. of Pittsburg, Pa., U.S.A., has required the establishment of a Canadian company which will employ Canadian workmen. This company will, by close alliance with its Associate American Company, benefit by its experience of the past as well as future, and will maintain in every respect the high quality of its products as has been done by the latter in its 30 years of successful manufacturing experience.

"Standard" Products are specified and used by the most prominent and most particular Canadian Engineers, Architects, Contractors and Buyers. Ask a user!

Before you buy, get "Standard" prices and literature. *Just mail a card!*

Standard Underground Cable Co., of Canada, Ltd.

Dept. J - Hamilton, Ont.

last summer and which was favorably reported upon by Dr. R. W. Brock, director of the geological survey of Canada.

Montreal, P.Q.—The Board of Control have at their disposal $800,000 and will use the same for improvements that are to be included in the supplementary estimates. The major portion of this amount has come in as revenue from tax arrears and according to the civic constitution may be spent on works other than those of a permanent nature.

Port Arthur, Ont.—The Board of Education has accepted the plans of Hood and Scott, Architects, for a 12-roomed school building in Coatsworth Park. Estimated cost $50,000.

Quebec, P.Q.—The management of the Dorchester Electric Company has purchased a large lot of land known as the Taschereau property. It is said that the company intends immediately erecting their workshops on the site.

Regina, Sask.—Builders resident in this city recently held a meeting for the purpose of forming a Builders' Exchange for the province of Saskatchewan, and later to become affiliated with the Dominion Exchange.

Sarnia, Ont.—The municipal council have negotiations on with the management of a large steel manufactory. They have offered one acre of land free.

Stratford, Ont.—The ratepayers voted in favor of constructing a new market shelter at a cost of about $10,000. Other by-laws carried call for the granting of a free site to the Macdonald Thresher Company, the guaranteeing of an $8,000 loan to Mr. B. M. Williams, and to grant a loan of $5,500 to Mr. G. L. Griffith, who proposes the establishment of a sadlery and harness plant in this city. Mr. Williams requires his money for assistance in the organization of a woolen plant.

St. Lawrence River.—The Federal Government has secured by contract for another year the George Davie wrecking plant for use on the St. Lawrence River, it is also reported that in addition to this the shipping interests are taking steps to provide a thoroughly up-to-date plant, installed with wireless telegraphy and other modern equipment.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending April 15th, 1912:—

A Glasgow firm who sell all grades, crude and manufactured, of asbestos, are prepared to act as selling agents for Canadian mine owners not already represented in Great Britain.

A Liverpool firm make inquiry for the names of Canadian manufacturers of linseed cake.

A South of England engineering firm wish to appoint Canadian agents for the sale of their centrifugal and turbine pumps.

A London firm desires to secure agencies for Canadian importers and exporters.

From the branch for city trade inquiries, 73 Basinghall Street, E.C.:—

A London firm manufacturing a new patented tobacco pipe, and also a special pipe cleaner, seeks suitable Canadian resident agents.

PATENTS.

The following is a list of patents recently granted to inventors in Canada; the list is furnished by Messrs. Fetherstonhaugh & Company, Royal Bank Building, King Street East, Toronto.

J. H. McKittrick and G. S. Ransom, cremators; P. L. Robertson, screw machines; J. M. Farrow, spike machines; T. Allatt, apparatus for making spacers for antifrugal separators; A. G. Ham and A. A. Homm, hair spring tester; M. E. Colhoun and W. Colhoun, ladies' hat fasteners; E. Carlson, harrows; T. C. Fleming, window refrigerators; E. A. Gerth, Jr., an advertising device; H. A. Gorrell, whipholders; H. C. Hogarth, filters for wells; W. H. Landon, devices for tapping trees; F. A. Leslie, water coolers and heaters; J. McLaren, cocks; W. W. Ormsbee, Jr., containers; R. Roebuck, snow plows; C. E. Smith, tile draining machines; A. E. Williams, skirt elevators.

LESSON OF THE TITANIC DISASTER.

The Editor:

Sir,—We who build on land have learned some things from the naval architects and it is barely possible that they could learn a twist or two from us. The salvation of our buildings—from fire—lies in fire-resisting construction and small units of space where fire may originate; the salvation of a ship lies in making it fire and waterproof and cutting it up into as many water-tight compartments as possible.

Collision bulkheads, false keels and midship compartments are well enough, but not sufficient. The coal-bunkers, the trunk-hold, the supply compartments, any space about a ship that can be made water-tight should be so and have only emergency openings thereto and that can be closed from the bridge or automatically. But it seems to me, and I have had something to do with ships and am not altogether without experience, and I have advocated it for years (though mariners and naval constructors have steadfastly averred I was wrong) that the decks themselves be made buoyant. Not necessarily detachable decks that would float off in a wreck, a species of raft, as has been advocated, but just buoyant decks. Steel plates top and bottom of deep deck beams, very thin plates on the bottoms to save weight, but amply effective. There would be nothing to close off, no dependence in emergency upon man or machinery, but simply unsinkable construction. Between every two deck beams would be an air compartment. Suppose the ship be rammed by another, or rip its bottom open on ice, or have its bulkheads otherwise put out of commission, it would fill with water to the first deck. There would be encountered a species of "ship-preserver," not sufficient buoyancy to sustain the entire load, but enough to slacken the load. The water would rise to another deck, more buoyancy and so on up, perhaps submerging all but the top decks, but the vessel would float. You couldn't sink it in any storm or crash Let the accident rip parts of the decks off, still, as long as any beams held together, there would be buoyancy enough to sustain the wreck. Few ships have higher than eight feet decks. Make the deck beams light of section but deep, at least a foot, and then you have, whatever may happen to the vertical water-tight compartments, at least one-eighth of the bulk of the ship in horizontal, absolutely air-tight and water-tight ship-preserving space. Supposing, to get abundant thickness of decks, you have to build ships of one deck less in maximum height, surely that "loss" is as nothing compared to the advantages of having an absolutely unsinkable ship, something our naval architects have not yet given us.

F. W. FITZPATRICK,
4200 Sixteenth St.,
Washington, D.C.

A NEW DEVICE FOR THE DETECTION OF WATER IN HOLDS OF SHIPS.

An electric alarm to signal the presence of water in the hold of a vessel is the invention of Leon Ducharme, 160 Montcalm Street, Montreal, P.Q. It consists of an ordinary electric bell attached by wires to a cylinder with a float inside. As the water rises the float rises and closes the electric circuit, sounding the bell. The cylinder can be set to ring the alarm at any depth of water from inches to feet. The alarm can also be attached to the usual discindicator.

The invention claims that on a large ship with one of these cylinders in each compartment of the ship, all attached to a bell alarm and a discindicator in the chart room, the captain of the ship would know the very second that water entered his ship and be able to act immediately.

THE TRIPLEX BLOCK

A Triplex Block hung from a temporary rigging and used for laying pipe.

What is the Life of a Triplex Block?

WE don't know. Triplex Blocks built by the Yale and Towne Co. at the very beginning—twenty-five years ago—are still in actual use. The Triplex Block of to-day possesses greater lasting powers. With its steel parts—its chain superior to any other—its non-wearing gear movement—and the guarantee of a rigorous test before shipment under a fifty per cent. overload. It will outlast the man who buys it, no matter how young he may be.

The Canadian Fairbanks-Morse Company

LIMITED

Fairbanks Standard Scales — Fairbanks-Morse Gas Engines
Safes and Vaults

MONTREAL ST. JOHN OTTAWA TORONTO WINNIPEG
CALGARY SASKATOON VANCOUVER VICTORIA

A REINFORCED CONCRETE PAVEMENT.

During the summer of 1910 a reinforced concrete pavement was laid in Plymouth, Wisconsin. The base was laid 5 in. thick and the surface coat 1½ in. thick, according to standard concrete specifications. Three unusual features of construction were used in the building of this pavement. "Pecky" cypress was used for expansion joints in place of the usual asphaltum, or tar. The 1-in. by 8-in. boards were used along each gutter and every 4 feet across the street, and at the end of the ties of the street car tracks. These boards were used as forms for the outside of the cement gutters and as a template for the crown of the street. A considerable saving of lumber as well as time in placing and removing the same was thus effected.

The reinforcement used was Triangle Mesh, Style 7 woven wire. This was placed directly on the concrete base so as to lie between the surface and the base.

The surface-finished coat consisted of granite chips from ¼ in. to ¾ in. in diameter, granite screenings from ¼ in. down to dust and Portland cement in proportion to give the densest mixture. After this mortar was spread over the concrete base and the mesh, it was troweled smooth, and while still soft the larger granite chips were cast by hand over the surface of the pavement, giving the entire area a roughened appearance. Some of the stones disappeared entirely into the soft cement mortar, leaving depressions in the pavement, while the others sank in only part way. The result was a surface which, while level enough to cause no annoyance in riding over it, was still rough enough to overcome any slipperiness of surface.

This pavement, in monolithic squares of 40 feet, is now nearly two years old, has passed through two winters, and there is not the sign of a crack or a flaw in it. It is not slippery and does not wear perceptibly. The expansion joints have worn off some, but not enough to show any abrasion of the concrete along the edges of the boards. The contract price for this pavement, including grading, was $1.23 ½ cent per square yard. The pavement was designed and constructed under the supervision of Mr. W. G. Kirchoffer, of Madison, Wisconsin.

MINING CLUB IN VANCOUVER, B.C.

The Vancouver Mining Club was recently organized by a large number of the city's well known mining men.

Mayor Findlay outlined the objects of the association, and stated that it could and would, no doubt, take a very prominent place in the mining affairs of the province. The The public had lost faith in mining schemes for they had been victimized by the wild-catter and it was the duty of the club to put before the public the real facts of the different mining activities that from time to time excite the pubilc.

Mr. R. Hedley spoke of the work of other mining clubs. The Spokane Mining Club, he said, had aided the mining interests of that part of the country to a considerable extent. The club in Slocan had also done good work in making some mining promoters retract their prospects for getting rich quick. The association, in his opinion, would make Vancouver the headquarters of all mining activities for the province and would also be a place where reliable information could be obtained relative to the mineral resources of the province.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16347—April 17—Directing G.T.R. to construct within 30 days from date of this Order spur from main line into property of Clifton Sand, Gravel & Construction Co., in Twp. of Stamford, County of Welland, Ontario.

16348-49—April 20—Authorizing C.P.R. to reconstruct 8 bridges on its Crow's Nest, Lethbridge, Havelock, Red Deer, Mountain and Farnham Subdivisions; and construct bridge at mileage 38.7, Kootenay Central Subdivision.

16350—April 20—Approving location of Kettle Valley Ry. Co. between mileage 53.92 and 65 west of Midway, B.C.

16351—April 20—Approving location of James Bay & Eastern (C.N.R.) station grounds at St. Felicien, Que.

16352—April 20—Authorizing G.T.R. to reconstruct 5 bridges on its 12th District Northern Division.

16353—April 20—Approving location of G.T.P. B.L. Co. stations on its Tofield-Calgary Branch (11 stations).

16354—April 20—Approving location of C.N.O. Ry. through unsurveyed territory, Dist. of Thunder Bay, mileage 363 to 383 from Sudbury Jct.

16355—April 19—Authorizing C.P.R. to construct its Bassano to Irricano Branch across 13 highways and diversions in Alberta.

16356—April 22—Authorizing G.T.P. B.L. Co. to cross and divert highway in N.E. ¼ of Sec. 23, Twp. 53, R. 8, west 5th. Mileage 67.9, Alberta.

16357—April 23—Directing Bell Telephone Co. to extend its telephone lines into Township of York, to provide a telephone service to said W. E. Duncan, Wm. E. Riley, and J. B. Riley, work to be completed within 30 days.

16358—April 23—Dismissing application of city of Valleyfield, Que., re G.T.R. crossing at Edmond Street.

16359—April 23—Directing city of Montreal to commence work of constructing subway authorized by Order 10455 of April 28th, 1910, not later than 15th May, 1912, same to be completed within 6 months from 15th May, 1912.

16360—April 22—Approving revised plan of C.N.R. Standard Pile and Frame Trestle, for Eastern Lines.

16361—April 22—Approving location of Algoma Eastern Rly. Station at Nairn Centre, Ontario.

16362—April 23—Authorizing G.T.P. Ry. Co. to construct spur for Fitshugh Lime and Stone Co., Ltd., near Edmonton, Alta.

16363—April 13—Authorizing G.T.P. B.L. Co. to erect stations at 18 points on its Regina-Boundary Branch, Saskatchewan.

16364—April 23—Authorizing C.P.R. to construct its Kipp to Aldersyde Branch across road allowance at mileage 83.66.

16365—April 22—16366—April 18—Authorizing C.P.R. to construct three spurs for Tyndall Quarry Co., Ltd., near Winnipeg, Man., and spur for J. Wilson, near village of Como, Que.

16367—April 24—Authorizing C.P.R. to use and operate bridge No. 87.0, Swift Current Subdivision.

16368—April 23—Authorizing London, Lake Erie Ry. and T. Co. to cross with spur line into their gravel pit London and Port Stanley Gravel Road, at Lambeth, County of Middlesex, Ontario.

16369—April 26—16370—April 25—Authorizing G.T.R. to construct siding into premises of New Burford Canning Co., Ltd., Twp. of Burford, County of Brant, Ontario, and for Ford Motor Co., Ltd., in the Twp. of Sandwich East, County of Essex, Ont. (Windsor.)

16371—April 24—Amending Order 16150, March 20, 1912, by making Lot "1" read Lot "2" in recital and operative parts of Order.

16372—April 24—Authorizing G.T.R. to construct 7 bridges on its Holmedale Branch, Brantford, Ontario.

16373—April 24—Authorizing T.H. & B. Ry. to construct spur into premises of Fretz, Limited, Hamilton, Ontario.

16374—April 25—Approving locations of G.T.P. B.L. Co.'s stations on its Moose Jaw North-West Branch, (7 station sites).

16375—April 26—Authorizing C.N.Q. Ry. to construct spur on Prince Albert Street, Tetraultville, now Montreal, Que., for delivery of carload freight to residents.

16376—April 23—Approving revised location of C.N.O. Ry. station grounds at mileage 174.5, Twp. of Storrington, Ontario.

16377—April 24—Authorizing C.N.O.R. to cross seven highways in the County of Pontiac, Quebec.

16378—April 24—Authorizing C.N.O. Ry. (Montreal-Port Arthur Line) to cross public road between Lots 3 and 4, in Twp. of Bristol, County of Pontiac, Que.

16379—April 22—Authorizing C.N.O. Ry. to cross seven highways in the Twps. of March and Torbolton, and Fitzroy, Ontario.

16380—April 24—Authorizing C.N.O. Ry. to construct spur track to proposed local freight terminals in city of Regina, Sask.

16381—April 24—Authorizing C.N. Alberta Ry. to cross with lines and tracks of its main line under lines and tracks of G.T.P. Ry. main line in N.W. ¼ Sec. 3, Twp. 53, R. 18, W. 5 M.

16382—April 25—Approving by-law No. 1 of Pere Marquette R.R. authorizing Geo. C. Conn, E.T.M., and Wm. E. Wolfenden, G.P.A., to prepare and issue tariffs of passenger tolls.

16383—April 24—Approving location of Lumber Conveyor of T. S. Sims & Co., Ltd., Fairville, N.B., across C.P.R.

16384—April 27—Authorizing C.P.R. to reconstruct 5 bridges on its MacLeod, and Cartier Subdivisions, Alta. & Lake Superior Divisions.

16385—April 25—16386—April 24—16387-88—April 25—16389—April 26—16390—April 25—16391—April 22—Authorizing C.P.R. to construct spur for Redcliffe Clay Products Co., Ltd., Redcliffe, Alta. For Whiteworth Brothers at Pilot Butte, Sask. For Sovereign Lime Works, near Angus Station, Que. For Messrs. F. W. Baird & Son, Parish of St. Jeanne de Neuville, County of Portneuf, Que. For C.P.R. on Lot 95, Parish of St. Paul, Manitoba. For C.P.R. on Lot DGS, 25, St. John, city of Winnipeg, Manitoba. For James McLaren Co, Ltd., in Twp. of Campbell, County of Labelle, Que.

16392—April 29—Authorizing C.P.R. to expropriate for purposes of taking care of traffic, lands in the Parish of Kildonan, and part of N.W. ¼ of Sec. 17, Twp. 11, R. 4, E.P.M., to establish East Yard near Winnipeg, Manitoba.

Volume 22. Toronto, May 9, 1912

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The Canadian Engineer

An Engineering Weekly

HIGHWAY BRIDGES AND CULVERTS.

The question of municipal highway bridges and culverts grows in importance concurrently with the increased attention given to the matter of good roads; in fact it is the cost of these highway accessories that brings the cost of road improvement higher in one locality than another, and while thought and discussion is being given, in many municipalities, to good road construction, it is an established fact, as recently exemplified by the many disasters accompanying the spring freshets, that there is a dire need for general improvement in small bridges and culverts.

A recent bulletin issued by the Office of Good Roads, U.S., by Chas. H. Hoyt and William H. Burr, takes up the whole question of highway bridges and culverts in a concise manner. Some abstracts are presented herewith. A practice which has been in vogue and which has had an injurious effect, especially in the design of highway bridges, is the method of inviting bids upon the bidder's own plans without having a competent and disinterested engineer to pass upon the designs submitted. The total weight of the steel and the amount of shop work necessary to make good, strong connections determine largely the real as well as the economical cost of the bridge. The desire to secure the contract encourages the effort, under such conditions, to make the design light enough in weight to get the contract regardless of whether the bridge is designed to carry its load with a fair factor of safety.

Still a third matter which also has had an injurious effect upon the design of bridges, and which should be avoided in all cases, is the determination of those acquiring the bridge not to pay more than a fixed amount, which has been decided in advance, without sufficient information, such as reliable engineering inspection, preliminary plans, and estimates. The plan to be observed should consist of the following steps:—

(1) The services of a capable bridge engineer should be secured.

(2) The foundations should be tested to determine suitability, bearing power and economy.

(3) The location should be determined with a close approximation and a profile of a centre line made, showing also the results obtained by testing the foundations.

(4) The load which the bridge may be called upon to carry safely, anticipating reasonably the demands and growth of the future, should be decided upon. All highway bridges, at least those on main roads, should be designed to carry concentrated loads, such as road rollers or traction engines weighing from 10 to 15 tons each, with a reasonable factor of safety. Unfortunately for the traffic of to-day many of the present highway bridges were designed to carry only moderate uniform loads, and on this account for their light appearance and their inadequacy to meet present demands.

(5) After these facts have been determined, the engineer will be able to prepare plans for the foundations, abutments, piers, and the bridge itself, all of which may be designed to meet economically the conditions of the location selected. An estimate of the cost may be made and this should in all cases be used as the basis for an appropriation for the bridge.

The amount of attention and skill to be given to the foundations for any structure depends, first, upon the size and importance of the structure proposed, then upon the loads it must carry, and finally upon its type. To avoid misunderstanding, it may be stated that the word "foundation" is used throughout this bulletin to mean the natural bed or material upon which rest the footings for the piers or abutments for a bridge, or the walls or floor of a culvert. This bed may be either rock, sand, gravel, clay, or any other natural material, or an artificial foundation prepared of logs or other material, or it may be piles driven to support the structure.

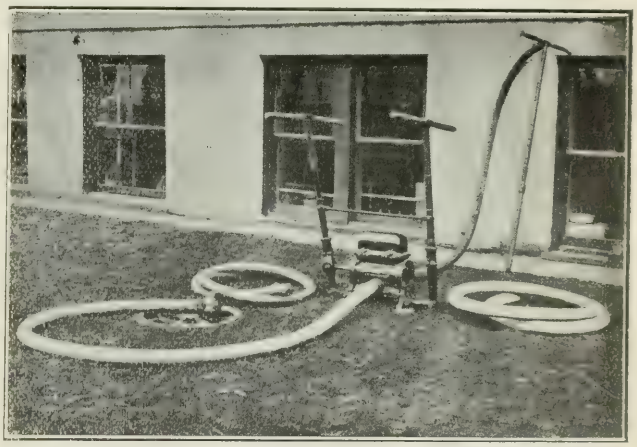


Fig. 1.—Wash-Drill Outfit for Testing Foundations.

For many of the smaller box culverts of spans varying from 2 feet to 8 feet and carrying only ordinary loads, the ordinary earth foundation is sufficient in most cases, with proper protection against undermining by currents of water. Where the streams are sluggish, however, or where the culverts are located in swamps and the foundations are soft and wet, a few logs from 10 to 12 inches in diameter, which are placed below in trenches and upon which the footings rest, add much to the stability of the foundation.

The logs, as shown in Figure 1, may be placed close together, or in many cases it will be sufficient to place them about 3 feet apart, centre to centre. The advantages of this type of foundation are that it distributes the pressure and tends to prevent uneven settlement or tipping of the side walls.

The suitability of foundations for the more important structures can be safely determined only by tests. This can be done best by digging test pits wherever conditions

will permit. In this way a better idea can be gained of the actual material in the foundation than by any other method.

Where conditions do not permit test pits, an iron rod may be driven to depths of from 10 to 20 feet, unless rock is encountered before that depth is reached. This method, however, gives very little idea of the material through which the rod is driven. A somewhat better way is to drive down 1-inch extra heavy iron pipe, which may be cut into 4-foot lengths coupled together as driven. A driving cap should be provided and the driving should be done with wooden mauls. Pipe has been driven in this manner in the winter months to a depth of about thirty feet or possibly more. The pipe, after being driven, may be pulled out with a small chain and lever, so that a sample of the material through which the pipe was driven may be brought up inside it. This material can then be examined as the pipes are uncoupled and cleared out. Material that sticks in the pipe may be loosened by placing the four-foot section of pipe in a small fire sufficient to generate steam from the moisture in the material, which, as it expands, forces the material out of the pipe. Great care should be exercised to have only sufficient fire to generate the steam slowly, or otherwise the material may shoot out the ends with considerable violence, or the pipe may burst and the flying fragments cause serious injury to persons in the immediate vicinity.

One of the best ways to test a foundation is with a wash drill outfit, consisting of a drill point to which is coupled 1-inch iron pipe in four-foot lengths. Water is forced through this pipe by a double acting force pump. Tests have been made with such an outfit to a depth of sixty feet and the wash drill may be used with or without a jacket pipe.

Figure 1 illustrates a wash drill outfit suitable for this use and which consists of a double acting force pump, with a cylinder 5 inches in diameter, a 5-inch stroke, a 2-inch suction and a 1½-inch discharge. The pump is fitted with two 12-foot lengths of suction hose with a strainer, two 12-foot lengths of pressure hose, twelve 4-foot lengths of 1-inch extra heavy iron pipe, and a drill point.

The kind of material in the foundation determines to some extent the size of the footings for the structure, with due consideration to the weight to be borne and the bearing power per square foot of the material. Rock makes the best foundation and should be used when it occurs at available elevations.

A great many tests have been made to determine the bearing power of other materials, and, while there is much variation in results, the following figures are given as indicating the range of values obtained and, in the absence of more definite information, they may be used as allowable working loads:

Material.	Bearing power (tons per sq. ft.)
Quicksand and wet soils	0.05 to 1.0
Dry earth	1 to 1.5
Moderately dry clay	2 to 4
Dry, stiff clay	4 to 6
Sand	2 to 4
Sand, compact and cemented	4 to 6
Gravel, cemented	8 to 10
Rock	200

There is, however, no definite rule by which the bearing power of a material can be determined absolutely without applying test loads and noting the amount of settlement caused by them. With the smaller highway bridges and culverts, which are the commonest built, an experienced builder is usually governed by his experience and good judgment concerning the suitability of a particular foundation to carry the proposed structure, but for any structure involving a considerable expenditure a careful test should be made.

Arch bridges or culverts especially require an unyielding foundation and are more than likely to fail unless such is provided. Consequently, they should not be built except where a good rock or gravel foundation is to be had, or possibly where a satisfactory foundation can be made by driving piles. Attention should be called to the fact that piles may be driven in an inclined position, and thus be able to resist the arch action directly.

The bearing power of piles may be determined for practical purposes, where comparatively stiff material is found, by the following formula:

$$\text{Safe load} = \frac{2\,WH}{S + 1}.$$

Here W = weight of hammer in tons or in pounds (the safe load is considered as in the same unit); H = its fall in feet; and S = the penetration in inches under the last blow. Results thus obtained, when compared with actual tests, show that this formula has a factor of safety varying from 2 to 7 or 8. It can be used properly, however, for comparatively stiff material only, for in soft material where long piles are to be used, it fails to give rational results.

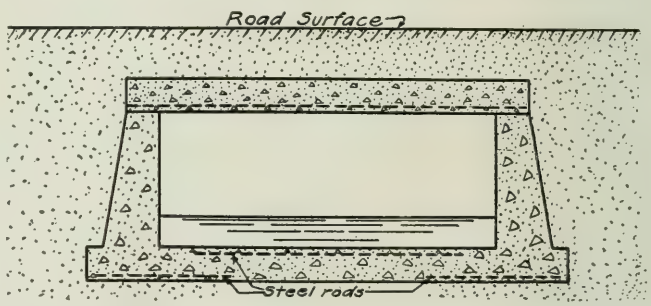


Fig. 1a.—Reinforced Concrete Floor, for Distributing Pressure Over a Greater Area and for Protecting Foundation from Erosion.

In locations where great depths of mud are found, piles are often driven that do not find a solid foundation, and the driving might be continued indefinitely, but, after leaving such piles for a few days, it is often found that several blows are required to start them again. This indicates that their bearing power has increased after the driving has stopped. It is a common practice to accept such foundations for certain structures as the best that can be secured, although they sometimes yield. In bridge construction, however, the success or failure of the structure depends much upon the foundation and too much care can scarcely be given to this part of the work.

It often happens that, after having tested the foundation and after considering the suitability of the material found, together with the elevation at which this material is available, it becomes desirable to shift the location of the bridge in order to secure a more economical substructure. For example, a suitable material for foundation may be found at a more convenient elevation in one place than in another, and this may materially reduce the cost of piers and abutments without injuring the alignment of the road seriously. In some cases it may even improve the alignment.

A survey and profile of the location should be made to establish the grade of the road. From these the amount of excavation and back fill may be determined, as well as

other quantities, distances, and elevations needed in preparing plans and in the execution of the work.

The simplest type of bridge or culvert that will be considered here is the wooden plank floor bridge for very short spans. This may be strengthened for increased spans, up to certain limits, by supporting the floor upon logs or sawed timbers. The life of timber, especially in bridges and culverts, is at best only a few years, in some cases ten, but usually, in the flooring at least, it is not more than three years. The price of timber is constantly advancing, and the liability of accidents from misplaced, worn-out, or broken plank is very great. While a timber bridge admits of theoretical design, there is no real need for its use to be encouraged, and it is the purpose of this article to deal with types of construction of a more permanent and substantial nature, such as concrete and steel.

The simplest form of concrete construction for bridges or culverts is the concrete floor or slab, corresponding to the wooden plank floor mentioned above. The concrete slab may be used for greater spans than the plank floor, and it may also be strengthened for greater spans by constructing concrete beams beneath the floor to support it. This is then known as the "T-beam" type of construction.

These types of concrete construction may be strengthened further by placing steel rods, expanded metal, or woven-wire cloth near the bottom of the slab, and steel rods near the bottoms of the beams. The advantages of using the steel reinforcement are that it has a greater tensile strength than concrete and that its location in the lower part of the concrete slab or beam brings it into tension when the beam is loaded. (Fig. 2a.) Moreover the compressive strength of concrete is greater than its tensile strength, and therefore the steel strengthens that part of the concrete structure which is subject to tensile stresses and is most liable to fail first.

This method is therefore more economical and makes it possible to bridge greater spans, within practical limits of cost, than can be done with plain concrete alone.

The application of the concrete slab is to be found first in the construction of box culverts. (Pl. V., Fig. 2.)

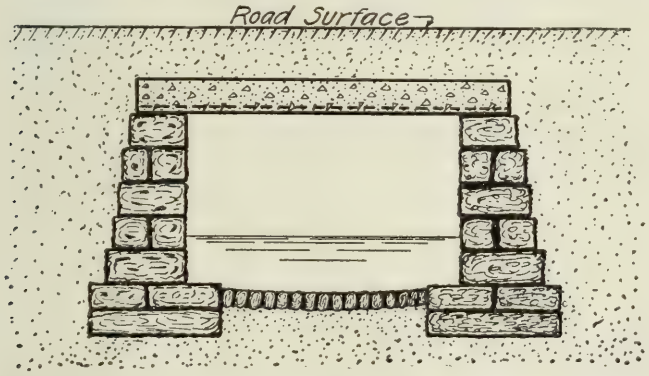


Fig. 2b.—Reinforced Concrete Slab on Masonry Abutments.

The box culvert gets its name from its similarity to a box with open ends. It has a floor, which may be of plain concrete or may be paved with stone. The two sides and wing walls at the two ends may be of plain concrete or reinforced with steel, but the cover and parapets should always be of reinforced concrete.

The sketch shown in Fig. 3a is made from a working plan prepared for a concrete box culvert, which has an opening 2 feet wide by 2 feet high.

This type of construction is practical under the majority of conditions for spans up to about 8 feet, which, as a matter of fact, forms a large percentage of all the culverts needed. Conditions may occur where it will be practicable to apply the box type, with some modifications, to greater spans than those mentioned, such as where the foundation is soft or liable to much erosion from swift currents. The floor may then be reinforced with steel, so that it will have greater strength to act as a beam to distribute the load over a greater area. It may also be extended back of the side walls to act as a footing. With suitable "cut-off" walls

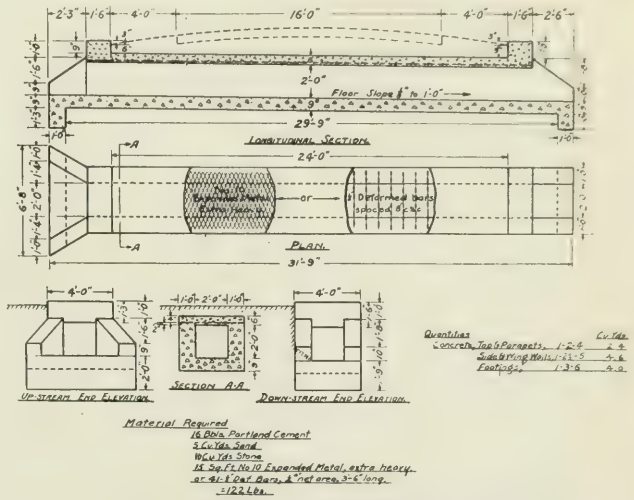


Fig. 3a.—Plan for a Concrete Box Culvert.

to prevent currents of water from running beneath this floor, the foundation will be well protected from erosion. Under such conditions this modified type, with further modifications in the cover, which will be discussed later on, may be practical for spans up to 20 or 30 feet. Figure 2a illustrates the principle under discussion. Here the reinforced concrete floor serves the same purpose as the logs, but the result is more permanent.

The length of the spans over which reinforced concrete slabs may be built within the limits of practicability and safety depends much upon the loads to be carried. The depth and amount of fill over the culvert, which may distribute the effect of the concentrated load, is also an important factor.

On main roads, where concentrated loads, such as road rollers or traction engines, are to be provided for and the depth of fill over the culvert is sufficient only to provide a cushion of earth from 1 to 2 feet in depth, the concrete slab is practical for spans up to about 10 or 12 feet, while for greater spans than this, under these conditions, other types better adapted to the longer spans should be used.

Under conditions of less severe loading the spans for the slab may be increased up to 16 or possibly 20 feet, but it does not seem advisable to use them for these greater spans in view of the possibilities of a nominal future growth of traffic requirements.

In some localities conditions may be favorable for building the footings and side walls of quarried or suitable field stone laid in cement mortar. While these will not prove more satisfactory than good concrete, it may be a matter of economy to do this, because of the saving in expense in crushing the stone for concrete. The reinforced concrete slab may be built quite as well upon such walls.

There are also many cases where masonry walls are already built, but have a poor wooden floor for the bridge. These floors may be replaced with a substantial reinforced concrete slab, which will be permanent.

Traffic should not be allowed directly on the concrete surface of the slab. Consequently it may be necessary to take off the top of the masonry abutments, so that the slab

may be set low enough to allow an earth cushion about 18 inches in depth to be placed on the concrete slab. There are also many other locations where the present bridge is set so low that it improves the grade of the road to construct the slab on the masonry abutments as they are found and then raise the grade of the road by placing the earth cushion over the slab (Fig. 2b.)

The reinforced concrete T-beam type of construction supplements the slab type and begins to be practical in point of economy at the point where the slab ceases to be economical—that is, for spans from about 10 to 12 feet and more—under the conditions of concentrated loads, such as road rollers or traction engines. This type of construction has been designed for spans up to 50 feet long, but whether or not it is practical for spans as great as that may depend upon several conditions, which must be carefully determined in each individual case.

One of the best types of culverts for spans from 10 to 30 feet long is the steel I-beam incased in concrete, upon which rests a relatively thin concrete slab which forms the cover for the culvert. The slab is designed to carry the load for a span equal to the distance from centre to centre of the steel I-beams, while the beams are designed to carry the load over the clear span from one side wall or abutment to the other.

working plan prepared in the Office of Public Roads for a 24-foot span concrete steel I-beam culvert.

Plain Concrete Arches.—The arch culvert is well adapted for locations in deep ditches or ravines, where there is an abundance of "head room," and it may be built over spans from 2 feet up. Many have been built over spans of from 50 to 75 feet in length. The Connecticut Avenue bridge in Washington, D.C., consists of a series of five arches, each 150 feet in span and built of plain concrete. A bridge in Germany has a single arch span of 215 feet, built of plain concrete. These two structures are rather exceptional, however, and are mentioned because of their general interest and not because it is intended to treat in detail of them or of structures of their magnitude in this bulletin. There are some noteworthy structures with a series of arches, and among them may be mentioned the railroad bridge at Rockville, Pa., which consists of 48 arches, each having a span of 70 feet.

The illustration shown in Fig. 3b is made from a working plan prepared for a plain concrete arch-culvert with a 6-foot span, which may be of service more often than those of larger spans.

The difference in the cost between an arch culvert for this span and that for a box culvert of the same span is not a matter of much importance. The advantage, if there is

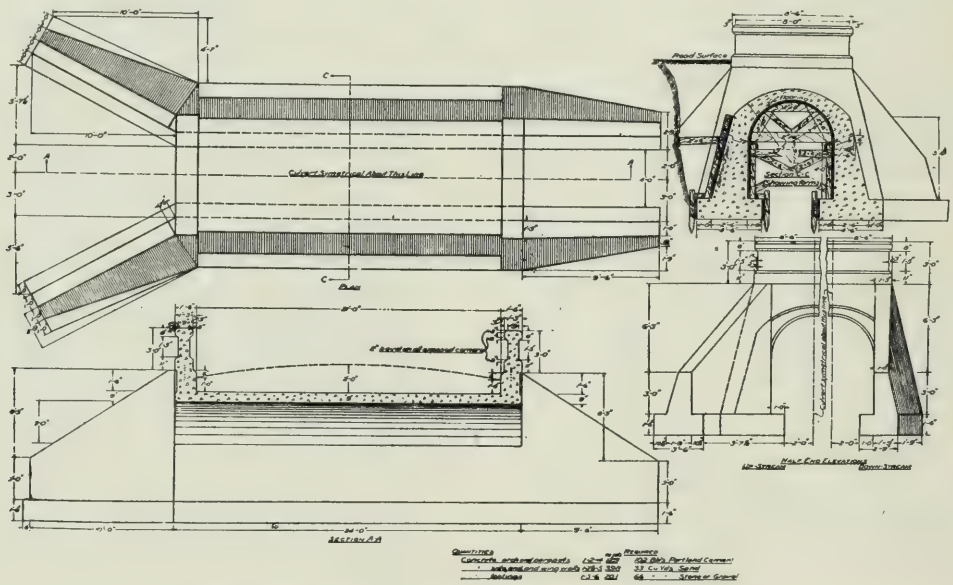


Fig. 3b.—Plan for Plain Concrete Arch Culvert.

Among the best features of this type of construction are its safety and ability to withstand severe and unfavorable conditions, such as the unequal settlement of abutments, which may cause cracks in the concrete that would cause other types to fail. In this type, however, the load is carried principally by the steel I-beams, whose strength is not destroyed by the settlement of the abutments.

Many structures of this type have been built without incasing the I-beams in concrete, but by merely painting the beams instead, to protect them from rust. The painting, however, must be repeated every few years, at some considerable expense. There is, of course, a great possibility that this painting may never be done, and the better way is decidedly to incase the beams in concrete during the construction, and thus protect them permanently.

This type also admits of arch construction between the beams for the floor system. By this means space may be saved in the depth of the floor system that may be of value in locations where the area of the waterway or the "head room" is a controlling factor. Plate VIII. is made from a

any, of the arch over the box type occurs very probably from the fact that no steel reinforcement is required for this arch as designed in the accompanying drawing.

Reinforced Concrete Arches.—The reinforced concrete arch has an advantage over the plain concrete arch in the fact that the curve of the reinforced structure may be made more nearly flat than the plain concrete arch, and thereby save in the total height of the structure. This permits it to be used where it otherwise could not. Under favorable conditions there may be an additional advantage in point of economy, although this can not be stated generally as true in all cases.

The steel reinforcement in the arch curves serves the same purpose as in the concrete slab—that is, to increase the strength of the arch rib where the concrete has excessive tensile stresses. In some cases, however, the concrete is also reinforced against compression. It is also possible, when steel reinforcement is used, to reduce the quantity of concrete in the arch rib from the amount that would be required for a plain concrete arch. The reinforced-arch type

of construction may be used for practically the same spans as stated for the plain concrete arches.

Footings for piers, abutments, and wing walls may be required for the purpose of distributing the pressure caused by the weight of the completed bridge structure and its "loadings" over a sufficient area to keep the pressure per square foot within the amount that will be carried safely by the material composing the foundation. In some cases, where the wall is designed for a gravity section—that is, without reinforcement—no footings will be required. This occurs, for example, where the side walls rest upon rock for a foundation. If the wall is of the reinforced-concrete type, then footings are practically always required. The cause for many broken wing walls is the lack of suitable footings under them.

As a matter of practical convenience in construction, footings are very generally built to "true up" uneven places in the foundation, and they are built up to some convenient elevation upon which the walls or piers rest.

The width of the footing is determined from the load to be carried and the bearing power of the foundation material. Its depth is determined from its width and the load carried; and, if constructed of plain concrete or masonry, its depth should be equal to its projection from the pier or wall, or even greater. The depth of the footing required to carry a load may be reduced somewhat by the use of steel reinforcement placed near the bottom to strengthen the projecting portions of the footing.

Another consideration that must not be overlooked in the construction of the footings is their liability to be undermined. They may, however, be protected by "riprapping" or paving around them, or by "cut-off" walls across the stream to prevent erosion of the stream bed at the location in question.

In view of the practice of the past, there is great need for the consideration of the subject of abutments and wing walls.

In many cases abutments and wing walls have not been built at all, but the four corners of the bridge span have been set on cylindrical piers or posts with possibly only a few planks to hold the earth approach. The rapid destruction of the planks and consequent sinking in of the earth approach often make dangerous holes at the two ends of the bridge. This type of construction is defective in the fact that it does not protect, but subjects the bridge and also its approaches to a greater possibility of being washed away by high water and swift currents. The damage thus caused is often more than the amount required to build substantial abutments and wing walls.

The abutment serves a twofold purpose: First, it supports the end of the bridge span resting upon it; and, second, it acts as a retaining wall for the material composing the approach to the span. The wing walls, too, serve as retaining walls and as a protection to the banks or slopes of the approach to the bridge from erosion by the water currents.

The abutment must then be designed, first, to support its load after the bridge is in place, and, second, to act as a retaining wall to resist the overturning forces of the material back of it before the bridge span is placed in position.

The wing walls must be designed to act as retaining walls. It is not the purpose of this publication to give a technical treatment of the principles of design, and it may be sufficient to say that, as a general principle, the thickness at the bottom of a retaining wall should be at least 40 per cent. of its height. This thickness should be increased if the wall is surcharged—that is, where the filling back of it is higher than the wall.

Piers.—The discussion of the subject of piers falls properly under the question of economic design. Whether or not it is economical to construct piers depends upon the relative cost of the different spans, and also upon the size of the piers required. The area of the waterway and the liability of piers to destruction by ice jams, logs, or floods, and the kind of foundation available are important matters and any one of them may be a controlling factor in the design.

From two designs for a concrete bridge with a 40-foot span and a 20-foot roadway a difference of about $200 in the cost of the superstructure alone appears in favor of building two 20-foot spans, instead of one 40-foot span. From this amount the cost of the centre pier must be taken to determine which is the more economical plan. Estimating the cost of concrete at $8 a cubic yard, including forms, it is possible to use 25 cubic yards of concrete for the centre pier. This would limit its height to about 8 feet in order to make the cost of the two structures about the same.

ELECTRIC CRANES FOR STEEL MILL SERVICE.

By E. Friedlaender.*

The rapid and cheap handling of all kinds and sizes of material by means of electric cranes has greatly influenced the making of steel products and helped considerably to reduce cost. One man can produce only about 33,000 foot-pounds of work in ten hours, where by means of a crane the same man could perform easily ten times as much work in the fraction of one minute.

Electric cranes are not nearly so wasteful in power consumption as hydraulic cranes; power is used in direct proportion to load lifted; on hydraulic cranes, however, cylinders have always to be filled, regardless of whether the hook is handling full, light, or no load. Nevertheless, the large number of gears, shafts, bearings, ropes, etc., on electric cranes cause a great amount of frictional resistance, which should not be overlooked. Good lubricated cut gears have an efficiency of from 96 to 98%, but when dry worn and out of alignment as low as 92%. Each bearing causes a loss of from 1 to 7%, according to lubrication and alignment. Rope stiffness reduces efficiency from 1 to 3%, depending on the diameter of sheaves and drums.

The total mechanical efficiency of electric cranes hardly ever exceeds 65 to 75%, and, together with electrical losses in motors, controllers and conductors, brings overall efficiency down to 50 to 60%. It is, therefore, very important to use the least number of shafts, bearings and gears possible to reduce dead weight to a minimum, and, last, but not least, keep all frictional surfaces properly machined, aligned and well lubricated. This will not alone decrease power consumption, but at the same time reduces considerably the cost of maintenance and repairs of motors and controllers. The wrong application of brakes can also greatly increase power consumption on cranes and punish severely all mechanical and electrical parts. Motors should not work against friction of brakes, but be released from it on the first step of the controller. This is easily accomplished by the use of magnetic-actuated brakes, but is entirely dependent on the skill of operator with hand or foot brakes.

More important yet is the proper speed control of crane motors; their rapid starting, stopping and reversing by unskilled men is not only very wasteful in power, but also very hard on all machinery, especially electrical. The best

* Abstract of a paper presented before the Iron and Steel Electrical Engineers, New York.

remedy is, probably, to take the control out of the hands of operators and predetermine acceleration, speed, torque and current through magnetic switches. This means, however, extra complication and expense, but will in the end pay for itself.

In regard to working efficiency of electric cranes, wherever a great amount of material has to be handled the general rule of keeping material always going in same direction should be adhered to as much as possible. It is very inefficient and costly to handle small loads at very high speeds over long distances on large and heavy cranes. In deciding on the speed of different motions we should not lose sight of the fact that the normal load hardly ever exceeds one-fourth maximum load and speed should rather be made to suit normal load; work in foot-pounds should then be made the same for the maximum load. Series direct-current motors are better adapted to this than alternating-current motors and will give, for this reason, a better working efficiency.

The proper type of girders should be selected for the work to be done by cranes. Heavy double or single-leg gantries should not be used where fast and continuous bridge work is required. It does not matter whether box lattice, single-web, or rolled-beam section is employed for girders; all will give equal satisfaction if properly designed. It is erroneous to think that lattice girders on outdoor cranes are not so susceptible to wind pressure; experience has proven that the four rows of angle braces of girders cause as much resistance as plated girders of same capacity. The fish-belly girder allows material to be used to best advantage; the square lattice girder, however, is easier fabricated, as all sections at different points are alike; it makes a rigid and stiff construction, if properly braced, with the least dead weight.

Gears, bearings and shafting may be regarded as the most important parts of cranes. On their proper design depends largely the efficiency, safety and cost of maintenance of cranes. Wherever possible, worm, bevel, split and overhanging gears should be avoided. All gears should be of steel, with standard involute-cut teeth; all high-speed gears should be made of high carbon steel properly tempered and to run in oil-bath. No pinions with less than 13 teeth should be used, as they will run rough and are liable to be mechanically weak.

Although only one-half maximum load can come ordinarily on one tooth, for the sake of longer life and safety each tooth should be made amply strong to stand entire maximum load. As all gears on cranes are worked in either direction and continuously reversed, teeth should be made so strong that they will resist absolutely all bending stresses; otherwise crystallization and breaking of teeth would be the final result. One cannot recommend too strongly to run all gears, wherever possible, in oil-bath; the resultant noiseless and easy running of the crane, as well as better efficiency and lower cost of upkeep, would soon pay for it.

All brackets and bearing supports should be made strong enough to avoid deflection of shafts and their binding in bearings. Where, on account of the light weight, it is impossible to prevent working and twisting of bearings, they should be made of swivelling type and be self-aligning.

The use of roller or ball bearings on cranes for mill work cannot be recommended, and should only be allowed where, on account of hand power, friction must be reduced to a minimum.

It is surprising that more use is not made by crane builders of oil-ring bearings similar to those on motors. Cranes equipped throughout with such bearings are always ready for work, much cleaner, do not drop oil on men and objects below, run easier and quieter, with less power consumption and cost of maintenance.

Cranes are generally handled much rougher than any stationary machinery and require continuous attention. They are naturally located in very inaccessible places, often high up, very hot, and dirty and smoky. Proper means should always be provided to give easy access to them without necessitating climbing of ladders or building columns; good stairways with railing, platforms and galleries on top for necessary inspection and repairs should always be furnished with crane structure. Crane girders should always have walks all around girder, and, if possible, trolley, to prevent slipping or falling from crane.

The use of over 275-volt currents on cranes cannot be recommended, as accidental touching of conductors is liable to be fatal. Even where electric shock is not dangerous, it may cause serious injury through fall by fright; therefore, bare conductors should be avoided as much as possible or be plainly marked by some bright colors. Means for preventing cranes from running away and wrecking themselves through wind pressure or accidental starting of motors should always be provided.

The proper location and arrangement of operator's cab is of great importance. Over yards, when material is often obstructing clear view, where operator handles material by means of grab buckets or lifting magnets without any assistance below, cab is best mounted direct on trolley. Man trolleys can be operated at higher speeds; manual brakes can easily be provided to control trolley and hoist motion, and crane can be wired easier and cheaper. Locating cab in centre on one side of crane, instead of on end of girder, gives operator often a much better view.

Crane motors are called upon to work mostly under very trying conditions, such as shocks, vibrations, frequent starting, stopping and sudden reversing, high lowering speeds, overloads, and many others, not to mention dirt, heat, rain and, last, but not least, lack of attention.

The ordinary commercial motor has been found unable to withstand continuously such conditions, and special mill-type motors had to be developed by motor builders for this work. Through co-operation with operating men, all weak, defective and undesirable features have been remedied, and there should be no trouble in getting crane motors which will stand operating conditions of mills and at the same time reduce cost of maintenance and repairs to a minimum.

Motor frames are now made entirely of steel and allow easy access and removal of armatures and fields, being split horizontally through field castings and bearings. The spider construction makes it possible to renew shaft or commutator without touching windings. Shafts are made much heavier, with larger keys and taper ends; core is pushed on spider instead of on shaft in such a way that it cannot get loose and damage windings or leads. Ample ventilation with very low core losses is provided; brush-holders have adjustable tension springs, bearings are arranged for oil-ring lubrication. Insulation is almost fireproof and will stand higher temperatures than on standard motors.

The poor commutation of high-peak current has always been a defect of crane motors, and caused frequent renewal of brushes and commutators. The introduction of interpoles on all crane motors has greatly helped to improve commutation and do away with rough and worn commutators, short-circuiting of bars, and final grounding of motors and burning of controller contacts, as well as blowing of fuses. Sparking and flashing over at brushes even with three times full-load current is not often encountered in interpole motors. The slower speed of these motors allows

quicker acceleration and stopping, with less braking effect and current consumption.

The usual practice of rating railway motors after one-hour full-load run with maximum temperature not to exceed 75 degrees centigrade, is the one that should be adhered to in most instances, especially on bridge and trolley motions, where, on account of fast acceleration of large and heavy masses, current values are liable to become very high. The half-hour rating will give motors large enough for cranes, which are generally not worked so hard and steady; as, for instance, in shops, engine rooms and over machinery in mills.

It should not be overlooked that the rate of temperature rise of crane motors is slow, in order to meet the one-hour rating, but that the maximum temperature is often finally exceeded and liable to deteriorate insulation if surrounding temperature is excessive, as is often the case in mill buildings. Manufacturers of electric machinery should state the maximum temperature their apparatus can be submitted to without any danger of injuring insulation, also what influence continuous high temperatures would have finally on motor windings.

In deciding on the proper size of a motor for certain work, not only weights, speeds and efficiencies should be taken into consideration, but, on account of rating of motors, the time of work and rest and average speed and load should be given attention. The great speed variation of series direct-current motors under changeable load should also be considered in determining size of motor, independent from the power required. The maximum speed of motion is always considerably higher than the mean speed, and could, of course, be reduced by accelerating and stopping in less time, but this would increase load of motor and necessary braking power and make wear and tear on gears, shafts and brakes heavier.

As the combined mechanical and electrical efficiency of cranes is only about 50 to 60%, not more than 22,000 foot-pounds of work can be gotten out of a 1 h.p. motor for crane work. This may give a somewhat bigger motor on small cranes, but would hardly be objectionable, as such cranes are working generally faster and more continuous than large cranes and are subjected to rougher treatment.

As the capacity of direct-current motors is mainly limited by the rise in temperature and motors are liable to exert torque greatly in excess of the capacity of the crane and cause serious breakdowns, devices should be provided to limit torque and current to a predetermined maximum and stop the motor before any harm is done.

In lowering a load the motor is assisted by the descending weight and is liable to attain very high speed, causing sparking and flashing at brushes and often serious injury to armature and field windings. The controller should, therefore, be arranged to prevent the speed from exceeding twice full-load speed. Alternating-current motors do not permit speeds much in excess of synchronous speed and can be counted on to take the place of mechanical retaining brakes. Operators, however, must be careful and not shut off power, as the motor would then be liable to attain very high speeds.

The alternating-current motor has encroached more and more into the field of the direct-current motor and successfully replaced same where speed and direction of rotation is constant. Their introduction for crane work, however, has been slow, for many reasons.

The series direct-current motor has speed-torque characteristics especially well adapted for crane service. To give similar characteristics to the alternating-current motor much of the simplicity and advantage of the alternating-current motor had to be sacrificed. The simple squirrel-caged motor had to be changed to a wound-rotor motor with slip ring and brushes. On account of closed slots, windings are tedious and difficult to put in place and to form into the required shape. Open or semi-closed slots would greatly simplify winding, but decrease efficiency of motor.

The maximum starting torque is not as great as on direct-current motors and regulation much poorer, as speed will exceed very little synchronous speed, even at no load and if maximum torque is exceeded the motor is liable to pull out and stop entirely, and cannot start again unless load is decreased.

The large magnetizing currents of alternating-current motors under all load conditions are liable to heat them up considerably when worked steadily, and must not be overlooked. These wattless currents do not represent energy and do not increase power consumption, but will heat up motors, transformers, generators and conductors. Voltage drop should be avoided as much as possible on alternating-current motors, as torque varies as the square of the applied electromotive force; this, of course, means heavier conductors on cranes and feeders than for direct-current cranes, where drop in voltage affects mainly speed, not torque. Efficiency at light loads decreases rapidly, and it is, therefore, advisable not to make motors too large for the normal work.

Although alternating-current cranes can handle a load just as delicately as direct-current cranes, they cannot perform as much work, i.e., act as quickly as direct-current cranes. Only the maximum loads can be hoisted at the same speed on both cranes, the speed of light loads and lowering being much higher on direct-current cranes. The suggestion of slowing down alternating-current motors for heavy work by means of resistance and of speeding up for light loads, to approximate direct-current crane work, means larger motors and lower operating efficiencies.

Single-phase commutator motors have about the same characteristics as series direct-current motors, and are better adapted for crane work than three-phase synchronous motors. However, they have been very little in use on account of complicated construction of motor and their inability to commutate large currents.

Since the introduction of electric motors on cranes and their ability to generate electric energy, great efforts have been made to use the generative control and do away with mechanical retaining brakes. The very same characteristics, which make series motors and their rheostatic control best adapted for crane work, are very detrimental for regeneration and do not permit very readily lowering step by step by means of dynamic braking. The self-excited series generator is slow in building up its field with resistance in circuit, allowing load to descend until the field is strong enough. Unless the operator handles the controller properly and the weight is sufficient to overhaul the drum, this rheostatic dynamic-brake control is hardly satisfactory.

By giving the series motor shunt characteristics, dynamic-brake control has become almost perfect. The operator can handle the controller as usual, and is able to lower either the empty hook or the maximum load step by step at any desirable speed. By driving the armature and field in two separate circuits and exciting fields separately, counter electromotive force can be lowered or raised above line voltage as desired. This, however, requires large rheostats in addition to controller resistance and brakes, which will release the motor when current is at its minimum value. The use of shunt brakes, or placing of series brakes with resistance directly across the line, would easily overcome all trouble.

OVERHEAD CHARGES.*

By Prof. Mortimer E. Cooley, Dean of the University of Michigan.

In the valuation of the property of public service corporations aggregating $1,100,000,000, I have had the honor to serve both the public and the corporation. By far the greater part of my work along these lines has been done for the public; and having in the beginning and for about seven years worked exclusively for the public, I naturally approached the problems from the side of the public and, it might be said, as against the corporation. It very soon became apparent, however, that either the contentions of the corporation were sadly at variance with the facts or the public was densely ignorant of the true state of affairs; and henceforth the real problem was to discover as nearly as might be the common ground upon which there could be no serious disagreement.

It must be said at the outset that the responsibility for misunderstanding rested largely if not wholly with the corporations. Their business is of a technical character and not readily understood by the layman without explanation, and the corporation official had not in the past felt called upon to make explanations, at least not of the kind inspiring confidence in the public mind. This is now seen to be true, and while not too late for correction the failure to comprehend its importance, even its necessity, at an earlier date has led to the very serious controversies of to-day, wars they might be called, between the public and the public service corporation. The public is fighting for what it honestly believes its rights and the public service corporation is fighting for existence.

Setting aside the mistake which has been made in the past of keeping the affairs of the corporation in a sealed book, any fair-minded man who will make a study of the problem with all the information now available must inevitably reach the conclusion that the present attitude of the public toward the public service corporation is as much at fault and quite as blamable as was the secretiveness of the corporations in the past. The public, slow to wrath, is a mighty force when once aroused and can no more be resisted than the ocean tide. It, however, reaches its height and begins to ebb in due course, and it remains to be seen whether in the future we shall profit by the experience we are now having and establish conditions far more stable, so stable in fact that a similar situation cannot again arise. Much swifter progress could be made in bringing the war to an end if the fight could be carried on by the master minds on both sides. History reveals that unfortunately that is not the way wars are conducted. Politics has prolonged many a war and delayed the re-establishment of peaceful conditions after the war itself was ended. The political charlatan thrives at such times and seeks to maintain the conditions necessary to his nefarious existence. But he is not the only parasite; there is also the unprincipled expert, scientific expert he calls himself, whose expertness lies in being able to set up an array of figures in apparent proof of any result desired or required of him by his boss. If anything he is more dangerous than his boss, because his weapons are figures juggled to suit his purpose, and only to be refuted by an expert on the other side, who, however honest he may be, is sure to be considered by the partisan equally unprincipled.

Opportunity for the Accountants and Engineers.—The real forces effective to end this conflict between the public and the public service corporation are the accountants and engineers—not to end it, perhaps, but to point the way so that the man who really desires to be fair may have before him the facts upon which to base his judgment. The public as a whole is honest and fair—it is only individuals who are dishonest and unfair—and once the ignorance of the public has been dispelled the true and correct solution will be in sight. But the engineer and the accountant, while in the main honest enough, are not to escape responsibility in some measure for their ignorance.

The engineer has not always dared to tell the whole truth, fearing it would not be believed, and that his reputation would thereby suffer. He has therefore told but a part of the truth, and now when the necessity for the whole truth is imperative his task is much increased, he being obliged to explain his earlier position. In many, and it is to be hoped in most, cases this earlier position of the engineer was due to ignorance of the real facts, or more likely to knowledge of only a part of the facts. It is only comparatively recently that the engineer has been called upon to work with the accountant and the financier in the development of all the facts in the creation of the property of a public utility corporation. Is it therefore to be wondered at that the public has remained in ignorance?

The accountant's share of the responsibility cannot be said to be due to ignorance or to any fear that his reputation might suffer from a disclosure of all the facts. It is repugnant to the average mind to wrestle with the mass of figures required in setting up the details of accountants. It should be possible for the man of average intelligence to enter an account and find there the essential things required in comprehending the cost and the value of a property and the expenses of operating and maintaining it. It should not be necessary for an expert accountant to spend months digging through accounts for the necessary data upon which to base costs and values. This criticism does not bear today with the force it did in earlier years, because of the study and effort on the part of accountants for a number of years past to devise methods or systems of accounting which will afford almost at a glance any particular kind of information desired. The accountant has rather been the custodian of facts, the keeper of the storehouse as it were, but now he must perform the additional task of preparing the facts for consumption. The facts required by the public at this time are in themselves simple enough; the difficulty lies in devising means to disclose them so that they can be easily comprehended.

Appraisals of Property.—The public desiring to inform itself as to the cost and value of a public utility property requires an appraisal to be made, that being the simple and obvious way to go about it. Prior to 1900 the principal appraisals of this class of property were of water-works. In practically all cases this investigation was made to discover the value of the plant with a view to taking it over from private to municipal ownership, the condition for the transfer being usually set up in the franchise. These appraisals were usually made by engineers, it being customary for the municipality and the company each to choose one or two and these to choose another who should act as chairman and cast the deciding vote in case of a tie. All too frequently the appraisers entered upon their work as advocates, each for the side choosing him, and the appraisal became a controversy, which had finally to be settled in the courts. The decisions handed down have become the law of the land which, while almost wonderfully good in the majority of cases, is not altogether applicable as precedents to many of the cases arising to-day.

The chief object in those days was to arrive at the value of the property, which included the so-called "going value" of the property. "Goodwill" was another element considered.

*Abstract of paper read before the American Electric Railway Accountants' Association, Atlantic City, N.J.

But to-day, and since 1900, appraisals are made not alone to discover the value of the property, but the cost as well. The appraisal to-day is not so much for the purpose of transferring the property from private to municipal ownership, although that is the alleged object in a few cases, but for the purpose of taxation and rate making and to determine the extent to which the issuance of securities can be authorized. Obviously it is to the interest of the corporation to have a low value for taxation and a high cost for rate making and the issuance of securities. But of course both cannot be had except as the facts justify them. And right there is the first obstacle encountered by the public and the corporation in coming to an understanding. The public fails to see any difference between the cost and the value and argues, not without some show of reason, that if the property has a certain value for taxation it surely ought not to be different for rate making and the issuance of securities. The fact that the corporation fights to keep its figures down in the one case and up in the other no doubt contributes in no small degree to the attitude of the public toward it. It is, therefore, important to discover first if there can justly be any difference in the two cases and, second, if so to what extent can such differences properly exist.

It is not so much my purpose in what follows to say what ought or ought not to be done as to indicate the things which must receive consideration in determining what ought or ought not to be done. The average individual thinks of the value of a public utility property as consisting merely of the things which can be found and inventoried; in other words, he thinks of the value as being made up of the physical elements only. For many it is quite a long step to add any intangible elements or to consider the capacity of the property to earn a return on the investment. The farmer, for instance, in placing a value on his land unconsciously considers how much of the different things can be raised, the first element of value being its earning capacity. Then he considers the physical structures, house, barns, fences, drainage equipment and stock and other things which he has had to add from time to time, and for which he has had to invest capital in one form or another. I venture to say that if a complete analysis of a farming property could be had, starting from the beginning, most if not all of the elements, or their equivalents, would be found the same as in a public utility property. The first thing, therefore, is to realize that the value of such a property does not lie in the physical elements alone, independent of their earning capacity.

Point of View of the Utility.—It aids materially in one's quickness of understanding to assume one's self to be the corporation and then to take the steps successively as they come in building up the property, putting it into operation and carrying it along until it becomes self-sustaining. One readily comprehends the outlay necessary to acquire the rails, the ties, the overhead work and the power plants and the labor involved in their installation. One does not, however, so readily comprehend the other outlays which, although they are not seen as tangible elements, are just as much present as the tangible elements themselves. These other outlays are in general grouped under the name of "overhead charges." The term is somewhat elastic; its scope will be greater or less, depending on the extent to which certain charges are considered as a part of the physical structure itself. For instance, the elements of contingencies and contractors' profits, if not included in the cost of the physical structure itself, would have to be considered as overhead charges; both are present and must appear in the cost somewhere. The practice of valuators is not uniform, some preferring to include those two items in the cost of the physical structure and others to separate them and add them as a percentage. Occasionally an appraisal has been made with no separate charge appearing to cover contractors' profits, but in such cases the unit costs have included them or the items have been taken from the contracts awarded on bids invited for the work. The contractor's bid includes, of course, both his allowance for contingencies and for profits.

A usual allowance for contractors' profits is 10 per cent. on the cost of the work. The item of contingencies varies with the nature of the work. There should, indeed, be two items of contingencies, one a construction charge, the other an inventory charge. The former may vary in an inventory from 1 per cent. to 2 per cent. to as much as 20 per cent. or 25 per cent. An example of a low percentage for this item might be found in the cost of a power unit the contract for which calls for the unit completely installed and operated for a time before acceptance, but in such a case the contract price includes a liberal charge for contingencies, as no contractor would think of undertaking the work without protecting himself against unforeseen expenses incident to such work. The same thing is true in the case of cars which are delivered on a contract. An example of the higher percentage may be found in a foundation or in a job of piping or station wiring. Making due allowance for varying conditions, an average charge of 5 per cent. on the cost of all items to cover construction contingencies is as low as it is safe to go. In the same way and for similar reasons another 5 per cent. should be added to cover inventory contingencies, making a total charge of 10 per cent. for contingencies.

It has been frequently argued that little or no allowance should be made to cover omissions from the inventory, the reason given being that the work has been done and all the items can be found and listed. But such is not true in fact. When the costs were figured in the first place complete plans and specifications were available, and quantities could be taken off and the difficulties of construction studied in detail. In making the inventory almost always no plans and specifications are available and there can be no comprehensive study from the work as done which will lead to the results obtained from a study of the plans without a liberal allowance to cover contingencies. Indeed, it frequently has been found desirable if not necessary to recreate the plans from the work as done before undertaking to value the structure. Numerous instances might be cited to show that even a total of 10 per cent. was an insufficient allowance to cover all kinds of contingencies. The use of a smaller percentage can be justified only when the unit costs have been determined from similar plants the actual costs of which were known, and in such cases the contingency item or a part of it will be found in the unit costs themselves. But even when the unit costs are such as to cover construction contingencies there remains the inventory contingency which must be added to complete the cost of the physical structure as it is listed in the inventory.

The charge for engineering likewise is a desirable item. Engineering usually covers the making of surveys, plans, specifications and estimates, inspection of materials and the supervision of actual construction work as it progresses. There should be added a charge for engineering in connection with each general item of the inventory which, depending on the nature of the work, may vary from 1 per cent. to 2 per cent. up to 10 per cent. and even more. Then there should be added to the cost of construction a general item of 2 per cent. or more to cover engineering not assignable to individual parts of the inventory. The total charge for engineering will in some localities not exceed 4 per cent. or 5 per cent., but in other localities it will go much higher.

Many of the earlier appraisals went no further than to include the cost as determined from an inventory, to which was added an allowance for contingencies and engineering.

The depreciation of the physical elements due to wear and exposure to the elements was then determined usually by assigning to each element a life and considering its age at the time of the appraisal. The result thus obtained was called the physical value of the plant, and to this were added any "going value," if it could be determined, and sometimes another value, that of "good will." The appraisal was then considered complete. While such a value, an approximation at best, might have sufficed in the older days of liberal dividends and little or no scrutiny of the affairs of a corporation, it in no way meets the conditions as they exist in these days of public demand. The public service corporation is no longer free to do merely the things which its management considers advantageous to do from the standpoint of insuring dividends. It is compelled to do things which involved expenses of such variety and magnitude that in some cases not only are the profits reduced to a point of practically no dividends, but there are insufficient net earnings to pay the interest on the bonded debt. It is this condition of things which renders it all-important both for the public and the corporations that the elements of cost and of value in a public utility property be made perfectly clear. This is the great problem of the day and it is all-important in that it affects the life itself of the public utility. It is equally important whether the utility be owned and operated by a municipality or by a corporation. The public service corporation is but the agent or servant of the municipality, and what affects one must of course affect the other.

Full Understanding Required.—The first thing necessary, therefore, for the man who would attempt to regulate the conduct of his agent or servant is to fully understand what is required of him. If a man has been successful in his own business it was due to careful study and a mastery of details. It passes comprehension that such a man should assume to direct or control a business about which he has but a smattering of real knowledge. If every man would apply or allow to be applied to a public utility the same principles which he applies to the conduct of his own affairs there would be little to complain of. What, then, are the things which the honest man should understand if he is to act wisely in the regulation of a public utility? Let that man put himself in the place of the public service corporation and see for himself the things it would be necessary to do. Imagine that he starts at the beginning. He is an active, perhaps a prominent, man in his community. He conceives that an electric street railway system would be a good thing for the community. He talks it over with some of his friends, the matter is carefully canvassed and the public sounded to discover whether there is any real demand for street cars. This may have taken several months, and required considerable time to be given to the project either by the man himself or some one employed for the purpose. Thus is a preliminary expense incurred.

It having been determined that a street car system is desirable in the interests of the public, its promoters must consider whether it would be desirable in the interests of the man who has money to invest. That is settled at once by the rate of return likely to be realized by the investment. Such a rate must be sufficiently attractive to divert money from other channels, and moreover the rate must be sufficient to meet any additional hazard not encountered in the ordinary channels of investment. A careful study must then be made of the routes, the necessary surveys and general plans worked out preparatory to obtaining a franchise. Thus a further item of expense is incurred. The franchise being obtained, it is necessary to obtain consent from property owners, which may be a very heavy item of expense. All of this work may have taken a year or several years. It is the development period of the project and all items of expense legitimately incurred are proper elements of cost to be charged to the property. Such items of expense do not appear in the inventory of physical elements of a property, and they are therefore an overhead charge. The extent of this charge necessarily varies greatly with the locality. Property consents alone have been found in some localities to run as high as $2.50 per front foot; in such a case the preliminary or development charge might easily reach $20,000 or $30,000 per mile, which would represent a percentage quite beyond belief by the average man. It is not yet practicable in most cases to separate the item of the development period so as to discover whether it might fairly be represented by a percentage of the cost varying between any definite limits. This item is altogether too frequently ignored even by experienced appraisers; or if not ignored it is included in the item of organization expenses, which item also frequently includes legal expenses. When so included the combined items may vary from 2½ per cent. to 5 per cent. and more, depending on locality.

The items of insurance, both fire and casualty, are now quite generally recognized as proper charges, the amount varying usually from one-half of 1 per cent. to 1 per cent.

Interest during construction curiously enough does not appear to have been thought of in the earlier days of appraisals, but the man of business knows without any argument that money cannot be borrowed without interest. The only question is on the time it should run. Six per cent. is accepted ordinarily as the rate, and the time is one-half the construction period. If, therefore, the construction period be one year the rate would be 3 per cent. of the total amount expended, assuming that the expenditures start from zero and mount uniformly to the total at the end of the year. The construction period in a street railway system is ordinarily taken as the time required to complete the power plant. This in a plant of any magnitude may be from two to three years. Along with interest the taxes must be included or set up separately, and it should not be forgotten that the interest item must also include the interest on the expenses incurred during the development period. Thus in a plant in a large city the interest charge might easily reach 9 per cent. or 10 per cent.

A BOOK OF VERSE.

Poetry is not much in the engineer's line. The Methodist Book and Publishing Company, Toronto, however, have just issued a volume entitled "Rhymes of the Survey and Field," which will appeal to those of the engineering profession who have been connected with outdoor and survey work. The author, Mr. G Blackstone Field, is an engineer at present engaged on surveys for the Canadian Pacific Railway in the vicinity of Wilker, Sask. The Rhymes deal with different phases of the fieldman's life in camp and on the road, and are written in a style very similar to Robert W. Service's poems.

PEAT FUEL IN DENMARK.

An English syndicate is spending large sums of money trying to develop coal turf from the Danish peat bogs. It has been estimated that Denmark can thus supply itself with fuel for 100 years to come, the bogs in this country containing about 300,000,000 tons of turf suitable for heating purposes.

The company is building its first factory in Zealand, where work has already started. The company has a capital of several million dollars and it is said that its operations will be extended to France, America, Russia, Siberia and China.

SELECTION OF A WATER-WHEEL UNIT.

By O. B. Coldwell.

INTRODUCTION.

One of the most interesting problems with which the engineer of a company utilizing water power has to deal is the selection of the hydraulic equipment for his plant.

With the exception of the tangential wheels used in high head work on the Pacific Coast and a few sections of the United States, it might be said that, for a good many years, most of the water wheels used in this country were located on streams near tide water and operated at heads below 60 feet (18 m.) Water wheels during this period were manufactured very largely along so-called "cut and try" lines and there were no well-developed principles of design. The experience gained during these early years of water turbine building and the knowledge derived through testing and operating such wheels has contributed very largely to the development of the art of water wheel building as it is known to-day.

Water wheels of this early period were for the most part used in mills of one sort or another to drive machinery which did not demand a very high degree of speed regulation. High efficiencies were occasionally obtained, but usually but for one point of load or for an exceedingly short range of load.

In recent years, due to the more general utilization of the water powers of the country and to the perfection of high-tension transmission of electricity, there have been many developments on the upper stretches of our power streams where the slope in feet per mile is very much greater and higher heads are more common. The operating heads of these plants range from say 60 to 400 feet (18 m. to 122 m.) for intermediate heads, from 400 to 1,000 feet (122 m. to 305 m.) for high heads and from 1,000 to perhaps 2,500 feet (305 m. to 762 m.) for extreme high heads.

Changed conditions are now met with. Many of these modern plants are of the hydroelectric type, requiring a nicety of regulation which was not known in the early period. Economy in the utilization of water becomes an important factor due to the characteristics of stream flow and the necessity of utilizing the available water to the maximum possible extent for the purpose of keeping the cost down to a minimum. In many such developments that part of the total cost brought about by the fixed charges on the investment exceeds greatly the part due to operation, and it is, therefore, important that the output be as large as possible. On account of the characteristics of the loads ordinarily imposed upon hydroelectric plants, the extent to which water can be stored has a marked influence upon the cost of generation in such plants.

Due to the various important factors mentioned above, there has been gradually perfected the highly specialized engineering science of water wheel design.

The object of this paper is not, by any means, an attempt to tell how to design a water wheel, but rather to discuss the features entering into the particular design which will best meet the conditions for which it is intended, and to point out the information which should be furnished by the purchaser to the waterwheel designer to enable him to plan the most efficient unit.

Although we have passed from the earlier period mentioned above into the later, in which a more thorough appreciation of the water wheel problem is required, it still remains a fact that in many instances very little engineering is being used in the selection of water wheels. This is perhaps due to a certain extent to the practice of manufacturers themselves in issuing trade catalogues. Those catalogues contain information regarding the discharge of water and horse power developed at given heads by various sizes of runners, but do not take into consideration such factors as variations in speed, variations in head, or other features which may have a large influence on the selection of the proper wheel. As a result, due to the custom of relying on catalogues in the past, many water wheels at present are being ordered directly from these catalogues without due regard and study being given to the conditions which should enter into the selection of the wheel.

In the following discussion an attempt is made to show that in general more thought should be given and more precise methods applied in selecting water wheel units.

Elementary Hydraulic Principles.—Having made the foregoing presentation of the scope it is intended to cover in this paper, there will now be brought to your attention a few elementary hydraulic formulas which will be employed later in the discussion. The elementary principles which are involved in these formulas should preferably be known and understood by the one selecting the wheel in order that he may properly cope with the questions which he should solve and be able to more intelligently place his order. The formulas given here are not, by any means, all of the formulas which enter into the complete solution of the hydraulic problem.

To begin with, a water wheel is a device which is placed in the path of falling water for the purpose of abstracting energy possessed by the water, due to its fall and weight, and delivering as much as possible of same to the shaft as mechanical energy.

The energy possessed by the water may be expended and made manifest as power as follows:

1. By allowing a quantity to pass from a higher to a lower level practically without velocity.

2. By the momentum possessed by a quantity of it traveling at a velocity caused by the head.

3. By pressure of the water due to head acting on an area through a space.

What usually takes place is a combination of these ways of expending hydraulic energy and making it manifest as power.

Total head is the difference in elevation between headwater and tail-water and is usually expressed in feet. This total head may be divided in general into three parts, as follows: friction head, discharge head, and effective head.

Friction head is that part of the total head which is applied in overcoming the friction in the water passages leading to and away from the wheel, as in the passage away through the racks, entrance to penstock, in the penstock itself, through the guides and buckets, and in the discharge tubes.

Discharge head is the head at which the water leaves the draft tube and enters the tail-race. In well designed wheels this is usually of small magnitude, but it is readily seen that this head is an absolute loss.

Effective head is the part of the total head left to be applied to the wheel itself for effecting the energy transformation after the friction and discharge heads are disposed of.

In the case of Francis turbines, the effective head includes the draft head or effect of draft tube; a tangential wheel has no draft tube.

* A paper presented at the Pacific Coast Meeting of the American Institute of Electrical Engineers, Portland, Ore., April 16-20, 1912.

Friction head loss in a steel pipe is found approximately by the following formula:

$$\text{Friction head} = \frac{l\ v^2}{3{,}000\ d}$$

l = length of pipe in feet.
v = velocity in pipe in feet per second.
d = diameter of pipe in feet.

When the quantity of water available in cubic feet per second and the effective head acting on the wheel are known, the approximate horse power is given by the following formula:

$$\text{h.p.} = \frac{\text{quantity} \times \text{effective head}}{11}$$

This assumes a wheel efficiency of 80 per cent.

The stream flow upon which the plant rating is based should receive careful consideration and study. If possible, accurate flow data over a number of years should be obtained. Many expensive mistakes have resulted from not giving sufficient weight to this matter.

Other fundamental formulas which might be mentioned here are:

h.p. $\propto \sqrt{h^3}$

rev. per min. $\propto \sqrt{h}$

Quantity in cubic feet per second varies as $\sqrt{h}$

Velocity in feet per second $= c\sqrt{2gh}$ where c is a constant having values dependent upon conditions of discharge. It is unity in value when water is discharged freely through a perfect nozzle, and in such a case, the velocity is the same as that acquired by a freely falling body and equals approximately $8\sqrt{h}$.

It might be said that the formula $v = c\sqrt{2gh}$ is the most important of all hydraulic formulas, as it enters into all calculations and designs of water wheels.

Types of Water Wheels.—We will now briefly mention some types of water wheels and the principles on which they act.

a. Gravity Type.—This type of wheel includes breast, overshot and undershot wheels. The efficiency of these wheels is often quite good, but the speed and power are extremely low, and this type is, therefore, not adapted to ordinary present-day conditions. We will, on this account, give it no further consideration.

b. Impulse Wheels.—This type of wheel includes the Pelton and Girard wheels. They are kinetic energy wheels, that is, the momentum of the mass of water in its impact with the runner buckets is the main principle utilized in the energy transformation.

In the Pelton type, the water strikes tangentially upon the buckets, while the Girard types, the water passes through the runner radially outward; an extremely careful design is necessary for this type.

c. Francis Type.—This wheel is a combined potential and kinetic energy wheel, the water passing either inwardly or outwardly through the runner. The wheel rotates partly from velocity action and partly from reaction due to pressure and consequent acceleration in the buckets. The so-called Smith, American, Holyoke, Jolly, Hercules, McCormack and Victor turbines are well-known wheels of this type. They received the above names years back when the so-called "cut and try" methods were used rather than theoretical design. This does not mean that these wheels are not good wheels. Much credit is due to the enterprise and achievements of the pioneer manufacturers responsible for their development.

Design and Calculations.—Hydraulic principles properly applied bring the design of a water wheel within the full grasp of the engineer. Hydraulic formulas contain many constants and coefficients, and it has taken time, patience and experience to gain a correct knowledge of the proper values of these. But once having gained a knowledge of them for various types of nozzles and surfaces, a full knowledge of velocity relations and correct design can be arrived at.

In general, the calculations necessary in designing a water wheel runner will be left to the manufacturer and will not be taken up here, but we will discuss briefly the manner in which the speed of a turbine runner is affected by the angles of the buckets and guides, as we will use this later.

Reference may now be made to the sectional drawings Figs. 1, 2 and 3, and the corresponding runners, Figs. 4, 5 and 6. These sketches show the general designs of the guides and runners for three types and angular relations of same. The diameter is the same for each runner.

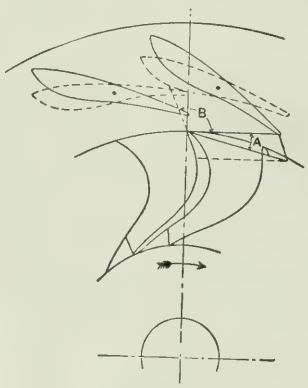


Fig. 1.
(See Fig. 4 for Runner.)

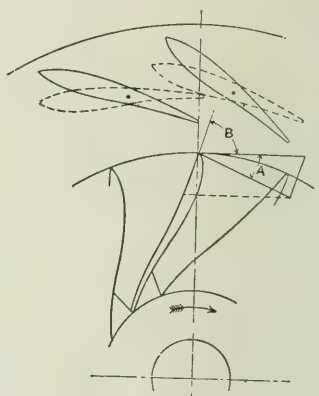


Fig. 2.
(See Fig. 5 for Runner.)

Let A equal the angle between the tangent of the periphery of the runner and the direction of the flow of the water as it leaves the guides.

Let B equal the angle between the tangent to the periphery of the runner and the entering edge of the runner bucket.

Let V equal peripheral velocity of the runner in feet per second.

Let H equal effective head in feet.

Led D equal diameter of runner in feet.

Then

$$v = 52\sqrt{H}\sqrt{\frac{\sin(A+B)}{\sin B \cos A}} \text{ (approximately)}$$

$$\text{rev. per min.} = \frac{60\ v}{3.41\ D}$$

A consideration of these two formulas clearly indicates that the diameter of the runner and the rev. per min. depend upon the angles chosen. Therefore, with a given diameter, to obtain rev. per min. angles must be chosen to suit and the design of the bucket made to correspond.

It is convenient to use in the process of design a head of one foot as a basis for calculations. Having made calculations for unity head, values for other heads are readily obtained by using the three fundamental formulas given heretofore.

h.p. $\propto H^{3/2}$

rev. per min. $\propto H^{1/2}$

Q $\propto H^{1/2}$

The choice and design of a particular type of runner to suit some given fixed condition can be based upon what is

known as "specific speed" of the runner. The formula for specific speed is

$$K = \frac{\text{rev. per min. } \sqrt{H}}{H\sqrt{H}}$$ and may be defined as: the speed at which the runner will operate when delivering unity horse power under unity head.

A given specific speed comprehends a particular design of one type of runner only. The designer fixes the angles A and B for each particular specific speed and thereby arrives at standard designs based upon specific speed. Probably no two designers would use precisely the same angles, and, therefore, velocity relations, bucket widths and openings will vary in runners intended to give equivalent performance. The variation, however, is not great.

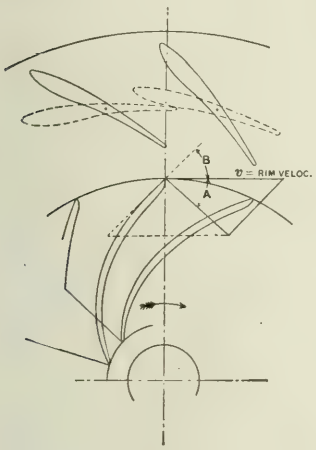


Fig. 3.
(See Fig. 6 for Runner.)

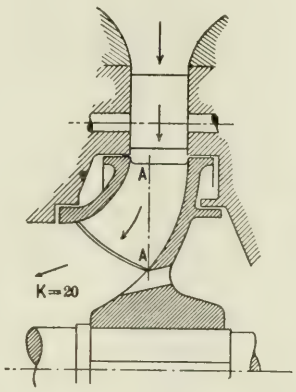


Fig. 4.
(See Fig. 1 for Section A-A)

Let us consider Figs. 1, 2 and 3. Fig. 1 is a runner of low reaction type which would be used on relatively high heads. Notice that the angle A of water leaving the guides is small, and the angle B of the bucket is greater than 90 degrees. These angles are selected to give a low peripheral velocity of the runner. If the values of the angles, which are approximately 14 degrees and 110 degrees, are used in solving the velocity equation given above and H is taken as unity, it will be found that v equals about 50 feet per second for this particular runner.

Fig. 2 is a runner of moderate reaction and is a type which would be used on lower head than the runner of Fig. 1. The angles in this case are selected to give a higher peripheral velocity of the runner. If values of the angles A and B, which in this case are approximately 23 degrees and 73 degrees, were substituted in the velocity formula, it would be found that v equals about 56 feeet per second.

Fig. 3 is a runner of high reaction, and would be used on lower heads than the runner in Figs. 1 and 2. The angles in this case are selected to give very high peripheral velocity. Their values are approximately 42 degrees and 46 degrees and the value of v if worked out by the formula is found to be about 71 feet per second.

A comparison of Figs. 1, 2 and 3 shows that as the type of runner changes from low reaction to high reaction the bucket angle changes from a forward curved bucket to a backward curved bucket. It is, therefore, evident that in order to get a high peripheral velocity, a backward curved bucket must be used.

Comparison of Figs. 4, 5 and 6 shows that in the case of the low reaction runner the width of the bucket is small, while in the case of the high reaction runner we have a very wide bucket for the accommodation of the larger quantities of water necessary. For relatively low power wheels, angles are used to give relatively low speeds, since these wheels are ordinarily used on high head work and small quantities of water are met with. For relatively high power wheels angles are used to give relatively high speeds since these runners are ordinarily used on low heads.

It will be noted that the runner in Fig. 4 is one with a specific speed of K = 20; in Fig. 5, K = 45; in Fig. 6, K = 75.

Francis turbines can be used for values of K as low as 12; for lower values tangential wheels should be used. This limiting value, however, is not well defined.

A manufacturing company ordinarily has available a number of types of runners, each of which has a particular value of K. Each one of these types is used for certain conditions and what is good in one case would probably not be suitable in others. The reasons for this will be brought out more in detail later on.

Fig. 7 is entitled "Comparative Efficiency Chart." On this chart the load on the runner is plotted in per cent. of its full load, while the efficiency is plotted in per cent. of the efficiency at which the wheel operates at full load. Curves for K = 20, K = 45 and K = 75 are plotted. It is readily seen on examining these curves that the efficiency will depend very greatly on the type selected. Let us say that we have a type No. 2 wheel installed, that is, a runner with K = 45; it will be noted that when this runner operates so as to give 60 per cent. of its full load the resulting efficiency is 103 per cent. of its efficiency at full load. If its full load efficiency is say, 82 per cent., then the efficiency of this runner when operating at 60 per cent. of full load is 103 × 0.82 = 84½ per cent.

Type No. 1 is used on high head work, No. 2 on medium head work, and No. 3 on relatively low heads. It is readily seen by examining the comparative efficiency chart that the efficiency which will be obtained by the employment of these different types varies through a considerable range.

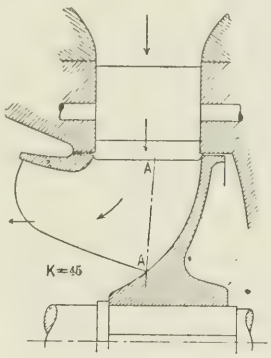


Fig. 5.
(See Fig. 2 for Section A-A)

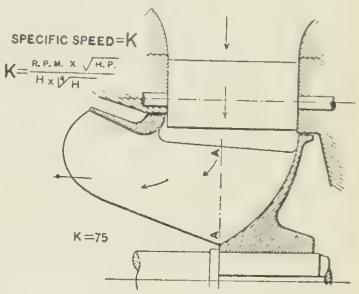


Fig. 6.
(See Fig. 3 for Section A-A)

A runner with K = 45 could not be used for very high head work and would, therefore, not enter into consideration for a plant which is going to operate at, say, 600 feet (180 m.) head. The principal reason why this runner could not be used with a head of 600 feet is that it would be structurally weak for that purpose. In the same way it is readily seen that a runner with K = 75 would not be suited for the high head work. On the other hand, a runner designed for a high head wheel with K = 20 could be used on a lower head, but in all probability would not be so used for many reasons.

(To be continued.)

THE BUILDING OF BREAKWATERS.

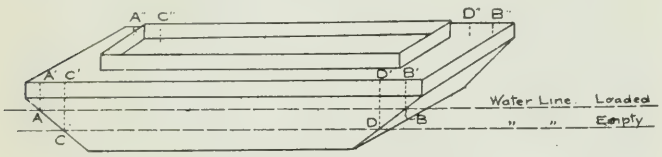
In a discussion of Mr. H. F. Alexander's paper on the "Building of Breakwaters at Lake Erie Ports," presented recently to the American Society of Engineering Contractors, Mr Howard J. Cole presents some interesting remarks. An abstract of his discussion presented to the society is given below.

Owing to the fact that rubble mound breakwaters are the most easily built and cheapest, and can be readily repaired after settlement or damage by storm, this type of construction is quite generally used.

The subject is of special interest owing to the activity in harbor improvements caused by the approaching completion of the Panama Canal. This activity is particularly noticeable on the Pacific Coast of South America, where the governments, with great foresight, are making strenuous efforts to increase their harbor and port facilities to provide for the trade that is sure to follow the opening of that canal.

Some of these governments have already completed the preparations for considerable work of this nature, and most of the plans call for breakwaters of the rubble mound type, with some modifications to fit conditions of each port Sometimes the rubble is topped with monolithic concrete block of 30 tons weight.

In the case of the Manzanillo breakwater, the rubble was obtained at a quarry twenty miles away from the work and cost the owner "in situ" $6.30 per metric ton. In a breakwater at Bar Harbor, Maine, that has been under construction, at intervals, since 1889, the stone, thus far, has cost the U.S. Government slightly over $1.00 per ton. These are in both instances contractor's prices, and include the actual cost and his profit.



Displacement Diagram.

Naturally, the cost of handling, production, etc., will vary according to the situation and with the method employed. If the quarry is handy to the shore, and barges can be loaded easily, a floating equipment will handle the material to the low water line about as cheaply as any other, but above that elevation other methods are better under most circumstances.

In the large works where it was necessary to convey the rubble to some distance, the work was largely carried out in a manner similar to the method of building a railroad fill, viz., by means of a temporary trestle.

On some work, where the writer was engaged, the materials (stone and sand) were delivered on deck scows and the displacement obtained in the following manner:

The exact dimensions of the scow were measured by steel tape and the point A' plumbed up from A, similarly B', B" and A" were obtained, and the distance A' B', A" B", A' A" and B' B" likewise measured by steel tape; the depths A A' and B B' and corresponding depths on the other side of the boat were carefully measured by a graduated rule and noted on a sketch of the boat. When the latter was empty the point C' was plumbed up from C, D' from D, and again on the further side, and the four dimensions corresponding to the loaded measurements recorded. From a comparison of the depths (light and loaded), and with the complete measurements taken, the displacement was computed as hereafter shown.

The length A' B' and A' A", and the other two corresponding measurements were obtained direct on the scow deck, and the depths were obtained by taking the difference between the readings loaded and light and the displacement thus figured.

By averaging the lengths A' B' and A" B" and multiplying by the width A' A", also averaging the lengths C' D' and C" D" and multiplying by the width C' C" and multiplying the average of these two by an average of the differences between the load lines (C' C—A' A, etc.,) at the four corners, one obtains the cubical feet of displacement, which multiplied by 62.5 and divided by 2,000, gives the displacement in net tons and is expressed in figures thus:

$$\frac{\left\{\frac{A'B' + A''B''}{2} \times A'A''\right\} \times \left\{\frac{C'D' + C''D''}{2} \times C'C''\right\}}{2} \times \frac{(C'C - A'A) + (D'D - B'B) + (D''D - B''B) + (C''C + A''A)}{4} \times \frac{62.5}{2,000} = \text{Displacement in tons}$$

which can be expressed in a somewhat simpler manner:

$$\frac{\left\{\begin{matrix}\text{Area of boat}\\ \text{on loaded water lines}\end{matrix}\right\} \times \left\{\begin{matrix}\text{Area of boat}\\ \text{on light water lines}\end{matrix}\right\}}{2} \times \left\{\begin{matrix}\text{distance}\\ \text{between the}\\ \text{two planes}\end{matrix}\right\} \times \frac{62.5}{2,000} = \text{Displacement in tons.}$$

SEWAGE DISPOSAL.

A new municipal enterprise which, it is expected, will have far reaching effects on the problem of sewage disposal is to be inaugurated at Bradford, England, where new machinery for extracting marketable produce from the city's sewage is being put into operation.

Last year, the corporation made a profit of $150,000 from the grease recovered from the sewage, and it is anticipated that at the new works at Esholt, the annual profit will be raised to $250,000. The total sales of these products up to last year reached $500,000.

Besides grease, a market has been found for the pressed cake which remains after the grease has been recovered, and large quantities of this have been exported to be used as fertilizers in France, South America and other countries. The cake has even been in demand as fuel during the recent coal strike and has been used as such in local factories.

Material reductions are made in the freight rates on the Temiskaming and Northern Ontario Railway in a schedule which will take effect on May 20th. The rates are equalized over the system so as to conform with the standard mileage tariff for Eastern Canada, and both for local traffic and through shipments charges are considerably lower.

The revision of existing grades and surveys for the double tracking of the Canadian Pacific Railway main line between Vancouver and Calgary, a distance of over 600 miles, is now under way. The work is in charge of F. F. Busteed, former general superintendent of the British Columbia division, who has established headquarters at Kamloops. Actual double tracking between this city and Port Hammond is now in progress.

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THE LATE JUDGE MABEE.

The death of Judge Mabee is a severe blow to the country. Natural ability and wide judicial experience placed him in an exceptional position for filling the chairmanship of the Dominion Board of Railway Commissioners, and during the past four years he has filled this difficult office as few men could.

The office of chairman of this Board is one which demands executive and administrative, as well as judicial powers. The Board was created in 1903 for the purpose of allowing of quick decisions without the hampering and restricting procedure of the courts. To be successful in operation the chairman of the Board must be a man of rare tact, quick judgment, administrative power, and forceful character. This in no mean measure had Judge Mabee. As a result, the Railway Commission has attained a strength and dignity, and its jurisdiction has been enlarged, until the work entailed is most wearing on the chairman.

Judge Mabee's death will be most deeply regretted both by the public and by the railways, to both of whom he was eminently fair, and by whom he was universally admired.

THE ENGINEER AND THE CONTRACTOR.

It is now generally accepted by the engineering profession that to secure the best results in the construction of any work there must be a cordial spirit of co-operation between the engineer and the contractor. The engineer's attitude towards the contractor will be reflected in the finished work. In a recent paper Mr. Charles T. Main, consulting engineer, of Boston, gives expression to certain opinions of what he thinks should be the attitude of the engineer. Mr. Main says:—

> "Reliable contractors are honest, and intend to live up to the plans and specifications. No contractor should be expected to give any more than is called for by the plans and specifications. Some contractors estimate low in the expectation of being able to get by with something inferior to what is called for. All men are human, and most are careless, and for these reasons it is essential to have as much inspection on a job as is necessary to see that the intent of the plans and specifications is carried out.
>
> "This work of inspection and of interpretation of plans and specifications should be done with the exercise of a good deal of judgment, with a mind open to the interests of both the owner and contractor, with clearness and firmness. In many cases where claims are made by the contractors, it is due to the fact that they are not familiar with the plans and specifications. In many cases, however, there may be a conflict or a chance of more than one interpretation to be put on them. In the decision of all of these questions the engineer should assume a judicial attitude and render his decision with fairness to all parties interested. His decision may not be satisfactory to either party, but it must be clear in his own mind that he has done right thing to all.
>
> "No one can see more clearly than he all sides of these questions and reach a proper decision. Sometimes that decision may not reflect any credit upon his own work, but it should be

met fearlessly, if the fault lies in the preparation of the plans and specifications.

"Care should be exercised in the preparation of specifications, so that they will describe the class of work and grade of materials which are intended and expected with clearness and conciseness. A better class of work should not be called for than is required for a particular purpose, nor should it be called for with the idea that something inferior will be obtained which will pass. Just what is desired should be called for in the specifications and demanded by the inspector on the work.

"The attitude of the inspector, or better, the resident engineer, should be one of assistance rather than of criticism."

If the above is accepted as a basis for the guidance of the engineer in his dealings with the contractor, there is no question that much good will result to both sides, and, while we feel that conditions are improving steadily, still there remain many ways in which by a conciliatory attitude the mutual relations of the two parties can be improved.

REFORESTATION AND THE FLOW OF STREAMS.

A number of factors enter into the question of the flow of streams, among which may be named precipitation, rainfall and snowfall; the extent and contour of the drainage area, nature of the ground and condition of the soil; condition of the surface (forested or clear), and the presence of storage reservoirs, either natural or artificial, in the stream. The whole question of river regulation has been given little attention in Canada, although it is one of considerable importance to the economic development of the country. It is generally believed that forest growth on the head waters of a stream tend to afford more uniform flow, for with the ground cleared the water quickly gets to the streams and flows away, with the consequent result of floods at certain times of the year and low water at other times.

While it is believed that the forests have a more or less great effect in equalizing the flow, there has been little accurate data to justify any statement on the subject. A bulletin was issued recently by the University of Wisconsin which deals with the flow of streams and the factors that modify it. This bulletin, while dealing primarily with Wisconsin conditions, is of considerable interest to Canadians.

Professor Mead, who had charge of the work of preparing the bulletin, draws the following conclusions, which are applicable more particularly to our conditions. He states that if forests have any effect on stream flow that can be assigned a practical value, such effects must be manifest by an actual change in the conditions of flow when deforestation occurs, but that in general the cutting of timber in Wisconsin has had no material effect, either favorable or adverse, on the high water, mean water, or low water flow of the stream, or on the regularity of such flow; that if any effects on stream flow have resulted from deforestation, they have been entirely counteracted and obscured by the drainage of marshes, the clearing of farm lands, the second growth of timber and brush, or other similar occurrences, and that in so far as all evidence examined is concerned, there is nothing to show that the planting of forests in Wisconsin would in any way add to or take away from the quantity or regularity of stream flow or decrease of flood heights.

These results, as authoritative data, show that in general little benefit can be expected from reforestation for the regulation of our streams. The construction of storage reservoirs appears to be the logical step for any system having for its aim the equalization of the flow of our streams. A good deal of emphasis has been heretofore placed upon the theoretical advantages to be gained from reforestation, and the studies of Professor Mead will undoubtedly do much to dispel false assumptions and to direct investigation of the subject along the right lines.

CONCRETE BLOCKS IN NEW YORK.

The following specifications were recently adopted for concrete block in Greater New York:

Hollow concrete building blocks may be used for buildings not more than three stories nor more than 36 ft. in height, under the following conditions:

No hollow concrete blocks shall be used unless made of the following composition: One part Portland cement, and not more than five parts of clean, coarse, sharp sand and gravel, or a mixture of at least one part of Portland cement and not more than five parts of crushed trap rock or other suitable aggregate approved by the superintendent of buildings. The aggregate shall be of such fineness as to pass through a one-half inch ring and be free from dirt or other injurious matter, and Portland cement shall be a true Portland and be up to the standard requirements set by this bureau.

All concrete blocks shall be cast true and square, and be of uniform shape and thickness when laid in courses. No such blocks shall be used until complete and satisfactory tests have been made by the manufacturer under the direction of the superintendent of buildings, and until an approval for the use of such blocks has been obtained.

No blocks shall be approved that do not at the age of 28 days develop a compressive strength of at least 1,500 lbs. per sq. in. of net section.

In no cases shall the hollow spaces of the concrete block exceed 33⅓ per cent. of the cross-section of the block. The thickness of walls or webs of such blocks shall not be less than one-fourth of the height of the blocks but in no case less than 1½ inches.

The thickness of walls for any buildings where hollow concrete blocks are used shall not be less than is required by the building code for brick walls. All such walls shall be laid in Portland cement mortar. All outside walls below grade must be filled in solid. No walls composed of hollow concrete blocks shall be loaded in excess of 100 lbs. per sq. in. of the gross section of the wall—that is, no deduction being made for hollow spaces in figuring the area.

Where beams or girders rest on such walls, suitable templates of iron, steel, or stone shall be provided under their ends, or the blocks under them shall be solid. Concrete lintels spanning an opening over 3 ft. 6 in. wide shall be reinforced by steel bars.

Every block must have stamped thereon the name of the manufacturer or the manufacturer's mark.

All walls of hollow concrete blocks, and beams used in same, must be anchored in accordance with Sections 41 and 60 of the building code.

EFFECTIVE STRESS IN BELTS.

In a recent issue of Zeits. des Vereines deutscher Ingenieure appears an account of tests on the limits of effective stress in belts of various materials. An abstract of the article appears in the April Journal of the American Society of Mechanical Engineers. Such tests require a large expenditure of time because overloading of a belt can be discovered only from the appearance of a permanent elongation, and an identical elongation is also found in a new belt which has not yet reached its state of resistance. Since, however, several hours are required for a belt to reach that state, there is always a danger in short tests with new belts of taking phenomena of the state of resistance for those of overload.

Tests of Link Belts.—The tests were made on two link belts of equal width, but unequal thickness, made up of links pressed out of specially prepared fibre, and provided with leather rims. The tests have shown that at a speed of 15 m (say 50 ft.) per sec., the total stress on the tight side of the belt must not exceed 30 kg per cm (166 ft. per in.) of width of belt, but at higher speeds may go as high as 35 kg per cm (193 lb. per in.) of width of belt. Link belts have been introduced because they combined the strength of double with the flexibility of single belts, and gave strong belts which could be used on pulleys of small diameter. These tests have shown that for speeds up to 20 m (65 ft.) per sec. link belts are far superior not only to single, but even to double, leather belts, but at higher speeds the centrifugal tension in the heavy link belt decreases the allowable useful load very materially, and at speeds over 30 m (98 ft.) per sec. link belts cannot be economically used at all.

Tests of Leather Belts.—For speeds up to 15 m (50 ft.) per sec. the total stress in the tight side of the belt did not exceed 23 kg per cm (say 126 lb. per in.) of the width of the belt, while for speed of 30 m (98 ft.) per sec. the total useful tension rose to 26 kg per cm (143 lb. per in) of width of belt.

Americans often assert that belts which are turned out with the hair side to the pulley last longer than when turned with the flesh side to the pulley, as is usual in Germany. Tests made by the author have shown that in belts turned with the hair side to the pulley: (a) the tension ratio, or ratio between the tension on the tight side and that on the loose side hardly exceeds 2, while in belts running with the flesh side to the pulley it can exceed 3; (b) the highest allowable tension is more than 3 kg per cm (12.6 lb. per in.) less than in the case of belts with the flesh side toward the pulley; the speed cannot be made more than 30 m (98 ft.) per sec., against 50 m (164 ft.) with belts with the flesh side toward the pulley. This shows that it is in every respect disadvantageous to let the belt run with the hair side toward the pulley. A belt running in that way probably wears out sooner because, as was pointed out by C. O. Gehrkens, such curvature reverses the way in which the hide grew on the animal.

Tests of High-Speed Belting.—A double cemented leather belt, 45 mm (1.8 in.) wide, stood very well a total tension on the tight side of 67.1 kg per cm (370 lb. per in.), at 60 m (196 ft.) per sec., and broke only when the tension rose to 95.9 kg per cm (say 530 lb. per in.). The allowable useful stress kn can be deduced from the formula

$$kn = (kT - kf) \times \tfrac{3}{4}$$

where kT is the total stress on the tight side, and kf the centrifugal tension.

Tests on Belt Fastenings.—In the tests with woven belts it was found that, as the speed of the belt transmission increased, the allowable useful stress diminished owing to the influence of the belt fastening, which at speeds from 25 to 30 m (81 to 98 ft.) per sec. caused such vibration and uncertainty of run that it proved to be impossible to exceed the speed of 30 m (98 ft.) per sec. The influence of the fastening is due to the following causes: (a) through the centre of gravity of the fastening describing on the pulley a semi-circle, an additional centrifugal tension is developed equal to

$$k'f = \frac{G}{bl} \cdot \frac{v^2}{g}$$

this additional centrifugal tension is thus a function of $\frac{G}{bl}$, or weight of unit area of the fastening, and that indicates the advisability of arranging the fastening in such a way that its weight be distributed over as large an area of the belt as possible; (b) the rotation of the fastening in coming on and off the pulley produces in it a moment of torsion which in its turn produces in the belt an additional centrifugal tension. This tension becomes negligible if the fastening is made of flexible steel bands, softer steel bands lasting longer than hard ones.

A REINFORCED CONCRETE INFILTRATION WELL AND PUMPING PLANT.*

By Frederick N. Hatch, Jun. Am. Soc. C.E.

In this paper will be given a brief description of the design, equipment, and construction of a pumping station recently constructed for the Chesapeake and Ohio Railway at Silver Grove, Ky., as a part of the terminal improvements carried out by the company with which the writer is connected.

It was estimated that the ultimate quantity of water which would be required to supply the terminal would not exceed 1,000,000 gal. per 24 hours, and that the demand would be at a fairly uniform rate throughout that period. As the terminal is near the bank of the Ohio River, water was to be obtained from that stream and delivered to two 100,000-gal. tanks on towers 45 ft. high.

The Ohio River at this point is subject to an extreme variation of about 69 ft. between low and high stages, and it was necessary to design a plant which would operate satisfactorily at any stage. It was also desirable that the plant should be as nearly automatic in its operation as possible, as it would have to be about 700 ft. from the nearest shop building.

Test borings, made at several points on the river bank, showed that the top soil is underlaid by sand and gravel, and that the river bed is in the same formation. With this in mind, it was decided to sink a well on the bank and provide openings in it so that it would receive water by infiltration from the river through the intervening sand and gravel. It was expected that water obtained in this way would not contain much suspended earthly matter, though the Ohio is a turbid stream during high-water stages.

The sounding taken at the point at which the well was finally located showed the different strata to be as follows, the elevation given being that of the top of each stratum:

* Paper presented May 1st, 1912, to American Society of Civil Engineers.

	Elevation.
Extreme high water in the river	407.3
Surface of ground, loam and sand	376.0
Loam and clay	361.0
Gravel, with some sand	354.0
Sand, with some gravel	343.0
Extreme low water in the river	338.1
Fine white sand	330.0
Bed-rock	291.0

The bottom floor was fixed at Elevation 328.0, or 10 ft. lower than extreme low water, and the motor floor is above the highest stage of water.

The pumping requirements and conditions are as follows:

Minimum capacity	700 gal. per min.
Maximum static head	127 ft.
Minimum " "	66 ft.
Discharge	through 1,000 ft. of 8-in. cast-iron pipe.

The pumps are to be driven by electric motors taking 3-phase, 60-cycle, 440-volt current; the motors are to be controlled automatically by the water level in the tanks; and all equipment is to be in duplicate.

Constant-speed, centrifugal pumps were selected on account of the great variation of effective head, and the fact that pumps of this type have a low starting torque, which is favorable to automatically-controlled, alternating-current, motor drive. The pumps are 5-in., constant-speed (1,140 rev. per min.), top-suction, vertical, single-stage, centrifugal turbines, manufactured by Henry R. Worthington. At low-water stages each has a capacity of 700 gal. per min. against a total head of 142 ft., and requires 43.5 motor h.p. to operate it; at high water, against a total head of 104 ft., the discharge is 1,150 gal. per min., and the required horsepower is 50.5.

Each pump is driven by a Westinghouse 50-h.p. squirrel-cage type, induction motor, mounted on a cast-iron base on the motor-room floor. Each motor is controlled by a separate automatic starter, the two starters being mounted on one board and connected to the power line so that only one motor can be operated at a time. The solenoid switches of the starters are actuated by single-phase current controlled by a float-switch on one of the tanks. In order to prevent too frequent operation of the pumps, the float-switch is arranged so that it does not close until the water level has fallen to a point 5 ft. below the top of the tanks.

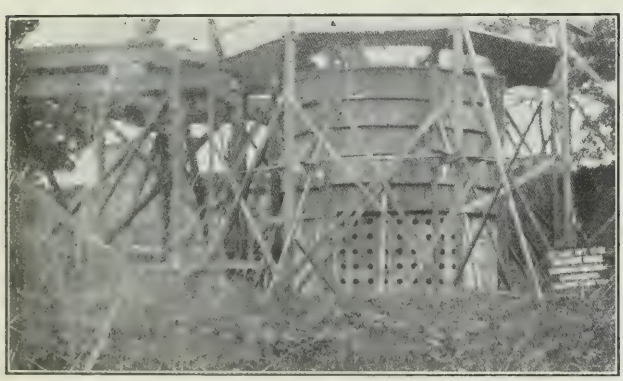


Fig. 1.—Lower Part of Shaft Before Sinking, Showing Openings Through Which Water is Admitted.

The shafts connecting the pumps to the motors are held in alignment by guide-bearings, adjustable in all directions, attached to rigid, built-up beams. The entire weight of the shaft and any possible unbalanced thrust of the pump impeller is carried by a marine-type thrust-bearing, mounted just below each motor. Flexible couplings prevent any of the weight of the main shaft from being transmitted to the motor rotor shaft and its separate thrust-bearing.

The entire shell of the well, including the motor-house and roof, is of reinforced concrete. The shell was designed to be sunk as an open caisson below the ground level.

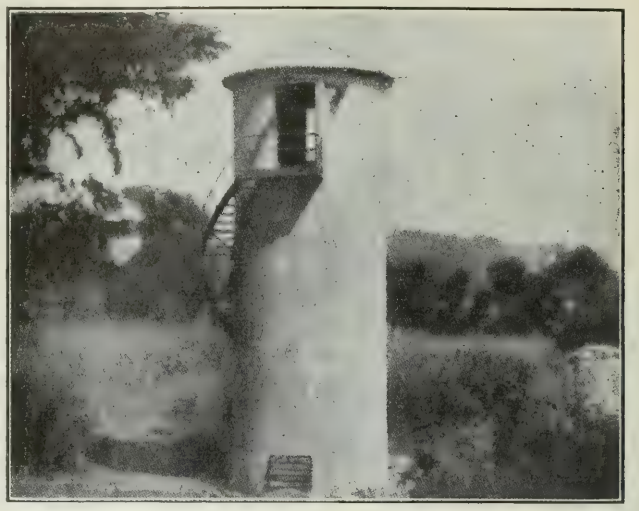


Fig. 2.—Completed Infiltration Well.

Sufficient reinforcement was provided to prevent the walls from pulling apart in case the upper part of the shaft should be held by the forms or the friction of the earth, while the power part was free. Besides providing for the erection stresses, the walls and bottom were reinforced to withstand any possible unbalanced earth or water pressure.

The motor-room floor was designed for a live load of 400 lb. per sq. ft. plus the concentrated loads of the motors, shafts, etc.

Water is admitted to the well through 63 openings formed by pieces of 5-in., wrought-iron pipe extending through the walls of the well below the low-water line. The aggregate area of the openings is 8.75 sq. ft. These openings are shown on Fig. 1, the photograph having been taken just after the sinking of the shaft began. Inside the well these holes are enclosed by a steel-plate chamber designed to withstand the unbalanced hydraulic pressure on the inlet side during high-water periods, with the inside of the shaft dry. A 24-in. sluice-gate, to control the inflow of water, is mounted on the side of this chamber. The gate is operated by a geared stand on the motor-room floor. To insure the proper spacing of the inlet chamber anchor-bolts, and also to provide an even joint surface, a steel angle companion flange was made with the flange of the chamber as a template. This companion flange was built into the concrete wall, and the anchor-bolts, which had enlarged ends tapped inside for 1-in. tap-bolts, were held in place by tap-bolts extending through the forms. A sheet-lead gasket was inserted between the companion flange and the flange of the chamber.

There is an opening, enclosed by a pipe railing, in the motor-room floor to give access to the lower part of the well, and steel ladders extend from bottom to top, inside.

The built-up beams for supporting the shaft guide bearings were designed for rigidity, and were set in pockets left in the walls of the well during construction. As the cover-plate serves as a walkway for inspecting the guide bearings, each beam has a pipe railing along one side of it.

A single I-beam, suspended above the motor-room floor and the hatchway, and extending as a cantilever beyond the entrance platform, serves as a track for a 4,000-lb. trolley provided to handle any of the heavy equipment.

An outside spiral steel stairway gives access to the head-house. The brackets supporting the stairway were built into pockets in the outside of the walls of the shaft.

The estimated weight of the well complete with its equipment is 530 tons, while the gross buoyancy during extreme high water, with no water inside the well, is about 465 tons, leaving a margin of stability of 65 tons, if the friction between the earth and the lower part of the shell is neglected.

Fig. 2 is a view of the completed well as seen from the land side. Fig. 3 shows the general design of the well with the equipment; but minor details have been omitted, and, to avoid confusion, some parts have been shown out of the true section.

Construction.—After leveling off the site, the steel-plate, cutting shoe was set up, and the forms were erected over it. The forms were of ⅞-in. sheathing nailed to waling pieces cut to radius. Those for the outside of the wall were supported by the posts of the working platform, and were held together, in sections, by steel bands arranged so that they could be loosened to allow the wall to slip through them. The inside forms were hung from cantilever brackets on the working platform, and were held in position by removable cross-braces, a construction which permitted the free use of the entire interior during the periods when excavating was being done.

The reinforcing rods were put in position, and a section of concrete about 5 ft. high was carefully placed and allowed to set. The forms were then loosened, and the material was excavated from the inside by a ¾-yd. orange-peel bucket handled by a derrick. As the excavation progressed the wall gradually sank. The operations of placing concrete and excavating were carried on alternately until the foot of the shaft reached its final position. The shell sank very freely through the earth, and it became necessary to provide some means of checking its descent at the proper place. This was accomplished by forming a concrete collar, integral with the wall, just above the ground level, and then taking a part of the load off the cutting shoe by blocking between this collar and the ground surface. The collar was designed to carry a large part of the suspended weight of the well if necessary. By the use of the collar the sinking of the wall was stopped at the proper place, and there was no settlement while the sand was being removed from beneath the cutting shoe.

Before the shaft reached the water level, the intake chamber was bolted in position and the sluice-gate was attached to it. When the excavation reached the water level, a large pulsometer pump was used to remove part of the water and fine sand.

As the flow of water through the open bottom of the shaft was too great to be handled by pumps, a diver was sent down to level off the bottom of the excavation and place the reinforcement for the rough bottom of the well; he also distributed the concrete for this bottom. After allowing the concrete to harden, the well was pumped dry and the finished bottom was put in.

The upper part of the shaft was constructed by raising the forms by stages as the wall was completed, and no conditions unusual to the construction of similar structures were encountered.

After the shaft was completed, the steel, guide-bearing supports were placed, leveled up, and grouted in place. Great care was required in getting the supports and bearings perfectly level and plumb, so that the vertical shafts would run smoothly.

This pumping plant has been in operation for some time, and it has been found, as anticipated, that the water reaching the interior of the well is free from suspended earthly matter, although at times the river has been quite turbid. At no time has there been a shortage of water in the well, even when the pump was running at its rated capacity and the river stage was very low.

The construction of that part of the well below the ground level was accomplished in 18 working days, and the entire part above ground in 6 working days.

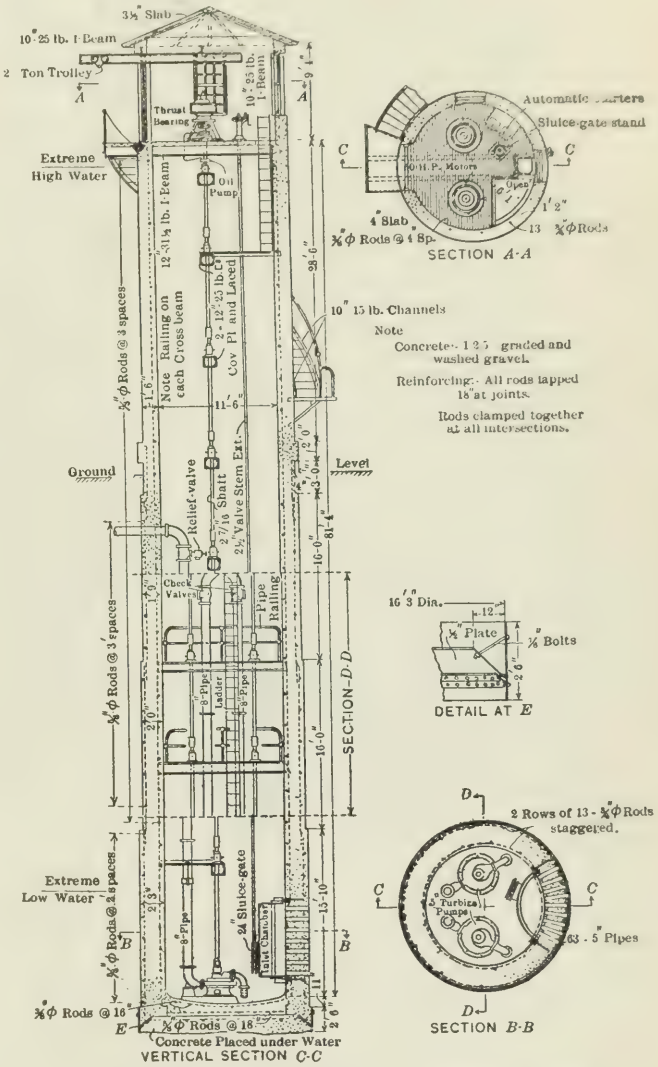


Fig. 3.—Reinforced Concrete Infiltration Well.

As the construction of the well was only a small part of the work done at Silver Grove, and as the entire job has not been closed up, only approximate costs can be given The figures show the actual costs of construction, and do not include engineering, drafting, and other overhead charges.

Grading and excavating	370 cu. yd. at	$1.65
All concrete, including reinforcement, material	280 " " "	3.15
All concrete, including reinforcement, labor	280 " " "	3.85
All forms, material, and labor	at	$2.85 per cu. yd.
All steelwork, fabricated and otherwise, material	28,000 lb. at	$0.052
All steelwork, fabricated and otherwise, labor	28,000 " "	0.022

(Costs of steel include painting.)

All equipment, piping, wiring, etc., in place.....$6,200

This pumping station was designed, constructed, and equipped by Westinghouse, Church, Kerr and Company, of New York.

EMBANKMENTS AND FOUNDATIONS—TORONTO-SUDBURY BRANCH C. P. R.*

By A. C. Oxley, S. Can. Soc. C.E.

The Toronto-Sudbury Branch of the C.P.R. was constructed in the years 1905-1909, and, as the standards were of a very high type, they may contain some points of interest. No curves over four degrees were allowed, and the grades were limited to 3/10 per cent. compensated. These grades were successfully maintained, with the exception of a pusher grade of 8/10 per cent., for some miles near Tottenham, mile 37. This difficulty will eventually be obviated when traffic demands it by the substitution for freight purposes of eight miles of 3/10 per cent. track for the present three miles of 8/10 per cent. Velocity grades were allowed within the limits of 10 and 30 miles per hour for freight trains.

The intention of the company was to insure a thoroughly solid roadbed, rather than to keep initial expenses at a minimum, and, as the greater part of its 225 miles ran through a rock and muskeg country, there was frequently some difficulty in attaining this result. This article, however, will deal only with the district between miles 22 and 182, north from West Toronto, from Bolton to Byng Inlet,

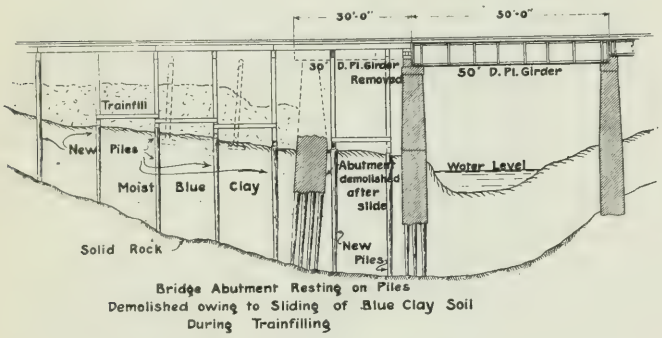


Fig. 1.

as this was the part with which the writer became personally familiar during his four years' experience on the work.

The line may be divided into two sections, viz., the earth district and the rock district, the first running from mile 22 to 92, and the second north from mile 92 to mile 248.

On the south, or earth section, little difficulty was encountered either with foundations or embankments. Eventually all streams and gulleys will be bridged either by steel viaducts, or by concrete arches and embankments, but at the time a number of permanent timber trestles were built, several of them containing an average of 500,000 F.B.M. The bents of these trestles rested on piles driven to an average depth of 20 feet or more, and the only settlement that has occurred has been on the ends of the trestles, where the bents rested on mud sills on the made embankment.

A curious instance of an over-refinement of engineering occurred at the Nottawasaga River trestle. The trestle is about 700 feet long, with a maximum height of 110 ft., and is located on the short tangent between two reverse curves. The trestle itself has an average elevation of 10 or 15 ft. below the general track elevation in the immediate vicinity. This is overcome by the use of 2,000 ft. of velocity grade of 6 or 7/10 per cent., resulting in a high rate of speed for the consolidated locomotive that passes over it. This will easily be remedied, however, when the trestle is replaced by a steel viaduct, either by building the viaduct higher or by slightly reducing the little summits adjacent to it. The curves also may be somewhat lessened by turning the new viaduct in a direction more nearly parallel with the tangents.

In the earth section water openings were either concrete or glazed tile pipes for small drainage areas, with concrete arches for larger ones. The pipes, on the whole, were very satisfactory, except that in a number of instances insufficient allowance had been made for their becoming reduced in area by being partially filled with water-washed sand; it was, therefore, necessary, under these circumstances, to replace 18 or 24-inch pipes with 4 ft. arches. The rule was to "camber" as high as the drop would allow, and the adjustment of the soil under the embankment was usually sufficient to take out quite a large curve, as "shrinkage" seemed to be due not only to the settling of the deposited embankment, but chiefly to the sagging of even firm clay in such a way as to cause a low spot in a pipe laid flat, and the consequent tendency of the pipe to clog. The culverts were the standard 1905 and 1906 types of concrete arches made in 20 ft. sections, to allow settlement. Piles were used in exceptional cases, a row under each side, but the general practice was to divert the stream far enough to secure firm soil.

In the rock country, practically all openings of eight feet or less were built up of the excavated rock and laid without mortar, those over four feet in width being made double, with the top constructed of flat-lintel stones. These proved entirely satisfactory in the great majority of cases, as they were laid on solid rock a little to one side of the original stream.

We will now proceed to deal with the rock section, discussing particular points in the order of their mileage from the south end. At mile 102, near Buckskin, a rock embankment about 10 ft. high crossed a fairly dry muskeg, in which the rock was about 50 or 60 ft. down. No cross-waying was ever permitted, as the intention was to have the rock embankment cut its way through the thin mattress of the dry surface of the muskeg; in this case the rock remained on the surface for about a year, and then gave way during train-filling. Some time was spent in filling it, as its depth allowed the train gravel to move sideways, but eventually bottom was reached after 3,000 Hart car loads of gravel had been placed in it. The only real objection to its sinking, when it did, was that the gravel used was high-grade surface gravel, which had to be hauled about 40 miles, as tracklaying had not then proceeded far enough to reach the more northerly, and thus more convenient, sand pits.

The only midway divisional point was at Muskoka, mile 126 from West Toronto. As this point was in the rock district the grading for it was rather heavy, the finished yard occupying an area, apart from the main passing siding, of about 3,000 x 300 ft., much of which was solid rock that had to be lowered about ten feet. Water was obtained from the nearby Stewart Lake, but, as it is not allowable to pollute the Muskoka waters, the sewers had to drain into the swamp on the other side of the track.

The general mode of procedure through the rock country was to make the rock cut only about a third of the embankment, as this quantity of rock would have sufficient weight to cut its way vertically through the mattress, and as soon as bottom was reached the remainder could be made by train-filling. The efficiency of this method of forcing the sink-holes through is shown by the fact that, train-filling once completed, the percentage of derailments has been at least as low on this new roadbed as on that of sections twenty years old or more. This brings up an important question. If the intention is to have the weight of the rock cut its way through the mattress, and as it is only when

* Paper read before Canadian Society of Civil Engineers.

it has done so and reached solid bottom that the earth filling becomes really effective, would it not be advisable, in some instances, before placing the rock fill, to cut right through the mattress parallel to the centre line, for instance, in the case of a thirty-foot embankment, to cut two longitudinal ditches forty feet apart, and thus allow that whole section to sink vertically without deforming the surface at the side? Almost every case of deformation is caused by the sand or gravel floating sideways, and it does not become solid for some time.

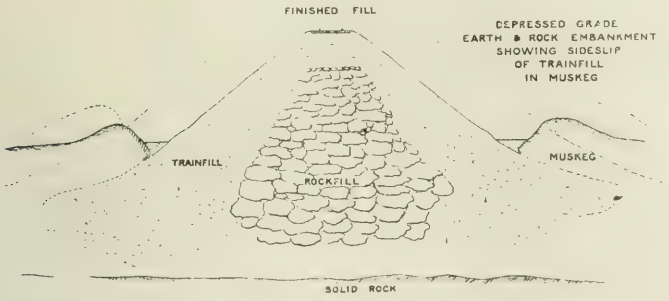


Fig. 2.

Depressed temporary grades of 3 per cent. were allowed. In many cases small hillocks of rock were cut away to allow the temporary grades to descend to the centre of the larger gulleys.

At mile 124, during train-filling, a low rock embankment, while carrying an engine, gave way suddenly, and the engine sank with such force as to shear the nuts in the track for a distance of 1,000 ft. or more. Between miles 112 and 142 a number of embankments were train-filled from temporary trestles, and little trouble was experienced, although in many cases it was found necessary to lower the level of adjacent small lakes in order to give more solid bearing to the toes of the slopes.

At Richmond Lake, mile 101, south from Romford, the lake level was about fifty or sixty feet below the level of the track. A rock embankment rested firmly on the solid rock below, but was not carried up to grade, a trestle being used above water level. The water would probably seep through the rock fill, but, in the event of its not doing so, it would easily flow through the trestle at high water. At mile 76, south from Romford, occurred one of the heaviest train-fills of the line, the depressed grade being no less than twenty-five feet at a maximum below the final grade, and, as it was necessary in filling to cover the toes of a rock embankment up to thirty feet in height, at least a quarter of a million yards of earth must have been used in this one-half mile of fill.

At mile 75.5, south from Romford, a temporary trestle beside a lake had been train-filled, but the water had apparently dissolved the embankment and caused lateral slipping. The lake was small, and the lowering of its level about four feet left the toe dry and firm.

In many instances, where a comparatively dry muskeg was to be crossed, provision was made for thickening the dry supporting mattress by ditching and lowering the level of the water table. This was generally effective, provided there was solid soil in the mattress, but not invariably. At mile 70.5 from Romford, the track crossed a muskeg about two thousand feet long and from twenty to forty feet deep, with an embankment when completed about four feet high. A drainage ditch was dug, leaving the water table only about four feet below the level of the surface soil. The track crept very badly and made "sun kinks," elevations taken during the passage of a train showing track undulations of one or two-tenths. The track was made safe for traffic and prevented from creeping by the substitution of 14-ft. bridge ties; later it was diverted to a side hill of solid rock and made thoroughly solid.

At mile 66:7, south, in order to make secure a muskeg, which for its length gave considerable trouble, a depressed grade was built, with a rock embankment about 10 ft. high, the lowest point of which was a maximum of about 20 ft. below the intended finished grade. In this case, although soundings showed a depth of 50 ft. or more to bed-rock, the weight of the rock embankment was not in itself sufficient to slice through the surface mattress. This was somwhat unfortunate, as it was always found that, although earth alone would eventually reach a firm foundation, yet, owing to its specific gravity being so low, it had a great tendency when placed by train-filling, to move horizontally rather than vertically, causing the mattress to bulge upwards for some distance out from the toes of the slope.

The writer was not present until the completion of the filling of this sink-hole but, although it had a length of only 600 ft. and had to be lifted to a height of 20 ft. above the depressed grade, a fill of 30,000 yards had raised it only 3 ft. Fortunately, by the use of spreaders, the embankment while sinking retained a good surface and alignment, and no difficulty was experienced in running passenger trains over this temporary velocity grade.

The next large fill occurred at the crossing of the Magnetawan River, the valley of which was about 3,000 ft. wide. With the exception of three girder spans this valley was crossed by a timber trestle about 40 ft. high. In this case the length of the trestle helped to reduce the unit cost of filling, as it was possible to fill from temporary grades placed on each side of the trestle, and thus leave the main line open for traffic.

It might now be interesting to mention a few of the bridges, with reference to foundations. On this 160 mile section, with two exceptions, there were no steel bridges larger than plate girders; the exceptions were at the Severn River, where there was a 200 ft. through Pratt truss, and at Parry Sound, where there was a viaduct 1,700 ft. in length. The largest span consisted of two Howe deck trusses of 165 ft. span. In the earth district all concrete was carried below frost line and rested on piles; while in the rock country the piers in almost every case rested directly on the rock itself.

During the construction of the Parry Sound viaduct a simple method was adopted to eliminate delay. The track was paralleled at the points by the C. N. O. Railway, and running rights, or rather haulage rights, were given by that railway over a four-mile section through Parry Sound. In this way it was possible to lay some twenty miles of steel north of the Sound during the construction of the viaduct, at the same time leaving the bridge contractors a mile or more of blind main line for bridge yard purposes. The only difficulty occurred at one of the abutments at the South Nascoutyong River. In this case the abutment was carried to a depth of 10 or 15 ft. below the surface of the ground, and piles were then driven to bed-rock, about 20 ft. further. Back of the abutment was a temporary trestle about 30 ft. high resting on mud sills, the soil being an alluvial clay, which was kept moist by the presence of a stream less than 100 ft. away. No trouble was experienced with the abutment until train-filling had proceeded for some time on the temporary trestle, when the earth filling caused a flow of the clay sub-soil, and, although the bases of the piles remained in their places on bed-rock, the flowing of the clay caused the abutment to tilt forward, necessitating its demolishment. No further attempt was then made to fill the embankment,

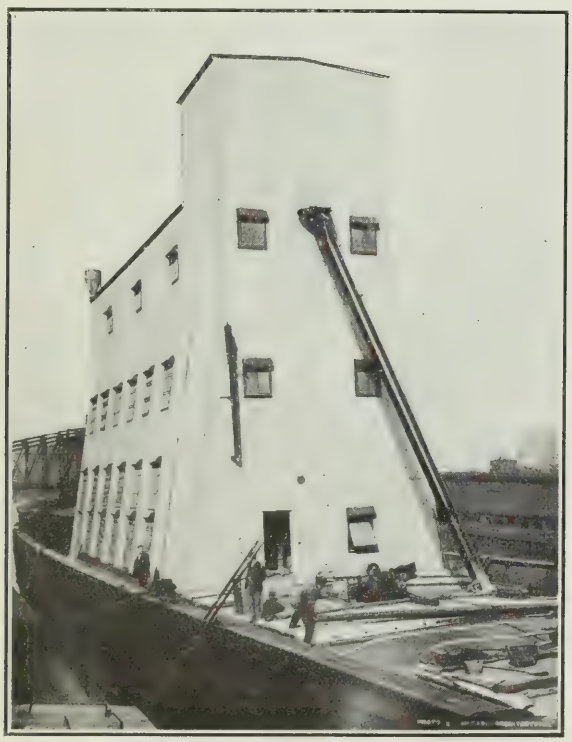
but piles were driven and a trestle constructed, both in place of the temporary trestle, and also between the abutment and the next pier, the new trestle replacing a short girder span.

In this case, even if the pier had been constructed just as it was, had piles for the temporary trestle been driven at once, the clay might possibly have been so firmly anchored that there would have been little, if any, horizontal movement.

ARMOUR FLOATING DRIER PLANT.

The Armour Grain Company has just completed probably the largest grain drier there is in the world at an investment of not far from $200,000. To build the drier they purchased and used the lake steamer "Helena," which has been in the grain-carrying trade on the Great Lakes. The length of the vessel is 310 feet and its beam 34 feet. It has a carrying capacity of about 125,000 bushels of grain. Upon this boat an Ellis drier has been constructed with a drying capacity in the neighborhood of 75,000 bushels in twenty-four hours.

The machinery is so constructed that grain can be put aboard the drier from any elevator, and, after drying, the steamer "Helena," with her own steam, can go to any point and discharge into any vessel, elevator or railroad car with her own machinery. In this manner there is avoided the necessity of unloading at an elevator having a marine leg.



Armour Floating Drier Plant.

In addition to the grain-drier constructed aboard the steamer "Helena," there is considerable storage capacity, which has been constructed with hopper bottom bins with conveyers, which will take the grain from this storage into the drying machinery. After being dried the grain can either be discharged from the steamer "Helena" or put into the storage bins aboard the boat itself. The whole plant has been constructed under plans and patents furnished by the Ellis Drier Company of Chicago.

The equipment aboard the boat is complete in every way, including electric lights, a laboratory furnished with moisture testers and other devices needed in a grain-drying plant.

A brief description of the drier equipment will prove interesting at this point. The driers are arranged in a battery formation, two six-unit machines to a battery. Directly in line with the driers are located the coolers, composed of two six-unit machines. Each battery is 28 ft. 4 in. in height by 10 ft. 2 in. in width. Both driers and coolers are constructed entirely of steel. Connected with each drier are steam coils of a special design for the utilization of exhaust steam. In connection with the coils are two automatic feed pumps and receivers, which take care of all water of condensation and pump it directly back to the boilers. As an extra precaution in case of breakdown these pumps are cross-connected.

Heated air to the driers is delivered by "Sirrocco" fans, each fan capable of delivering 110,400 cubic feet of air per minute. Air to the coolers is delivereed by a fan of the same type. While delivering this tremendous volume of air the fans are practically noiseless. All three fans are driven by an angle compound centre crank type engine, built by the American Engine Company, of Bound Brook, N.J. Steam is furnished by two Scotch marine boilers. This plant has been in operation about five weeks.

STANDARD SEWER SPECIFICATIONS.*

By E. J. Fort and A. J. Provost, Jr., New York City.

No standard specification for sewer construction which has been generally recognized or adopted as such, has up to the present time been produced and the specifications in use by even the largest and most important municipalities, vary widely in many of their most important provisions. Difference in local conditions would, no doubt, warrant special provisions in regard to some of the more important details, but there would seem to be little reason why, in the most important particulars, standard requirements may not be applicable.

Materials of construction of acceptable quality are usually available.

The functions to be performed by the finished structures are substantially the same, and if the structures are designed to be permanent, as economy and expediency would generally require, the standards of excellence in the materials and workmanship employed, may well be uniform.

Specifications for sewers of extraordinary size and special design will generally require addenda supplementing the standard specifications to meet the requirements in each particular case, while for pipe and masonry sewers of ordinary size, standard forms should ordinarily suffice.

It is the opinion of your committee that the complete instrument designed to govern every detail in the execution of contracts for sewer construction, should contain:

First—**A notice to Intending Bidders.**

Such a notice should state clearly:

(a) Time and place at which bids will be received.

(b) Location and extent of the work to be bid for.

(c) Time allowed for the execution of the contract.

(d) **Amount of security required.**

(e) Manner in which the bid shall be presented and its contents.

(f) Engineer's estimate of cost.

(g) General cautions in regard to preparation of bid and execution of work.

(h) Other information for the assistance of the contractor in the preparation of his bid.

*Abstract of a report to the American Society of Municipal Improvements.

Second—**Contract or Agreement Proper.**

The contract form should contain in addition to the language of the agreement, bonds, official signatures and acknowledgements of the same, and official designations of the fund from which the expense is to be met.

(a) A certified copy of the official action granting authority to execute such a contract.

(b) A description of the parties to the contract and the officials or employees under whose supervision it is to be executed.

(c) A statement covering in detail all the work to be done and the prices bid for same.

(d) A definition of the authority and duties of the engineer and assistants in control of the work as the representatives of the city or party of the first part.

(e) A definition of the rights of the contracting authority in determining the time of commencement, supervision of work, methods of precedure, force to be employed, etc.

(f) A definition of the contractors' obligations in executing the work in accordance with specification requirements and the directions of the supervising authority, and in maintaining the same, in the protection of property from damage, the payment for labor and materials, the completion within contract time, manner and time of payment, liquidated damages for delay beyond the contract time, etc.

(g) Method of procedure in modifying the contract.

(h) Clauses relating to liens, claims, damages, guarantees, assignments, etc.

(i) Enumeration of the provisions of laws and ordinances especially applicable to municipal contract work which must be observed.

(j) Other clauses of special or local application.

Third—**Specifications.**

Following a general description of the work embraced in the contract and the limits within which it is to be done, the limits within which the lines may be located, manner and times of fixing grades by the engineer, the manner in which measurements shall be made, etc., the specifications should include:

(A) A description in detail of all labor performed both preliminary and subsequent to the emplacement of the sewer structure, and the manner of its performance.

(a1) Excavation of Trenches.

1. Dimensions for various sizes of sewers and lengths to be opened at one time.
2. Shoring and bracing.
3. Pumping and baling.
4. Foundations, their preparation to receive the sewer.
5. Disposition of excavated material.
6. Provisions for the maintenance of street traffic while work is under way.
7. Removal of pavements and disposition of paving material.
8. Protection and support of other structures.

(a2) Refilling of Trenches.

1. Character of material to be used especially about sewer.
2. Manner of placing, ramming, flooding, etc.
3. Disposition of surplus, deficiency, how met.

(a3) Embankment.

1. Dimensions.
2. Character of materials, how placed and compacted.
3. Provisions for traffic through intersecting streets.

(a4) Replacing of Street Surfaces.

1. Unpaved streets. Surface to be restored; maintenance period.
2. Pavements, curbs and sidewalks out of guarantee; how restored; maintenance period.
3. Pavements, etc., under guarantee; how restored.

(B) A description in detail of all materials to be employed; their quality as shown by standard tests, and their proper manipulation to produce the finished structure.

(b1) Cement and Mortar.

1. Cement, quality, standard tests to be met.
   Cement, how delivered and stored.
   Cement, measurement of volume.
2. Mortar, measurement and proportions of ingredients.
   Method of mixing.
   Character of sand.
   Amount of water.

(b2) Concrete.

1. Size and character of stone or gravel.
2. Size and uniformity of sand grains.
3. Proportions of ingredients to be used in mixture.
4. Methods of mixing, placing and surfacing.
5. Molds and forms.

(b3) Brick Masonry.

1. Quality and size of bricks to be used.
2. Manner in which they are to be laid and protected from injury. (Inverts, arches, haunch walls, manholes and catch basins, spurs and branches.)

(b4) Stone Masonry.

1. Quality and dimensions of stones. Rubble, ashlar and dry masonry, coping stones, basin heads, etc.
2. How laid to produce finished walls and structures.

(b5) Steel and Iron.

1. Rods for reinforcement, quality, dimensions and tests.
2. Structural shapes, quality, dimensions and tests.
3. Expanded metal, wire mesh, etc.
4. How placed in the finished structure.
5. Spikes used in platforms, grillages, cribs, etc., quality, dimensions, etc.
6. Cast iron.
   Quality and tests.
   Conformity to place.

(b6) Sewer Pipe.

Specification for pipe sewers and sewer pipe is to be in accordance with recommendations of Committee C4 of the American Society for Testing Materials, appointed to report upon "Standard Specifications and Tests for Clay and Cement Sewer Pipe." The work of that committee is not yet completed. Its last annual report, June, 1911, is referred to. .

(b7) Pile and Timber Foundations.

1. Bearing Piles.
   a. Kinds and quality of timber.
   b. Dimensions.
   c. How driven.
   d. How measured and paid for.
2. Foundation timber.
   a. Kinds and quality of timber.
   b. Dimensions as shown on plan.
   c. How laid and secured.
3. Sheathing and Bracing Timber.
   Manner of Placing
   a. To remain in the work.
      Kind, quality, dimensions, etc.
   b. To be withdrawn.
      Kind, quality, dimensions, etc.

(b8) Sewer Connections.

1. Manner and time of connecting house drains.
2. Connections intersected to be re-connected.
3. Flow of old sewer—how cared for.
4. Method of making all connections.

(b9) House Connection Drains.

1. Spur pipe to receive house connection drains. Spacing and size. How laid.

2. Standpipes on deep sewers.

3. Cast-iron pipe for house connection drains, where necessary, how laid, quality, etc.

(b10) Manholes.

1. Concrete, brick.
   How built, dimensions, etc.

2. Manhole heads and covers.
   Standard plan.
   Weights, dimensions, etc.
   Quality of iron.
   Inspection.

(b11) Sewer Basins or Inlets.

1. Standard plan.

2. Excavation, dimensions, how made.

3. Heads and gratings or pans.

4. Traps.

5. Culverts, dimensions, how laid and connected to same, etc.

6. Restoration of curb, sidewalk and pavement after construction.

FLOUR MILLING AND MILL ENGINEERING.

At a meeting of the American Society of Mechanical Engineers held in Philadelphia, March 30, 1912, a paper was presented by B. W. Dedrick, instructor of milling and mill engineering, Pennsylvania State College, State College, Pa., on Flour Milling and Mill Engineering. An abstract of the paper is given below:

The ancient builder of mills was called the millwright, and, even up to comparatively modern times, was the only person capable of designing, building, and placing machinery and planning buildings for their accommodation, not only of flour mills, but factories or whatever machinery was employed.

The modern flour mill building does not depart radically from other buildings designed for the reception and operation of heavy machinery, but the height of building and floors is given more consideration. Mill buildings are usually carried up three, four, five or more stories above the basement. It is necessary and better economy to have sufficient height in order to place certain machines one above the other, so as to take advantage of the force of gravity in the handling of stock. In designing mill buildings, the engineer must also take into consideration the great weight to be supported, not only of the heavy and numerous machines required and their driving connectors, spouts ad bins, but of the grain and flour that is kept within the building. Besides, in the modern mill nearly all machines used are rapidly revolving, and if improperly placed or balanced, are particularly hard on a building, causing a perceptible weaving motion or tremor. The floors have to be of proper height to give sufficient pitch or incline to spouts, for if the spout is too flat or of insufficient pitch, the flour or other material will not run down, but choke or clog. The flour mill building, especially on the grinding and bolting floors, should be well lighted by a sufficient number of windows in day time, and electric or other good light at night, for it is necessary frequently to inspect the flour and other stock, and a good steady and bright light is absolutely essential to detect the extremely close shades in the color of flour, and to compare it with the standard samples.

Practically the first step of the wheat in the mill is in the separators, of which there are usually two: the receiving, that rough cleans the grain as it comes into the mill, taking out straws, wheat heads, sticks, oats, seeds and other trash; and the mill separator, that handles the wheat, cleaned almost entirely of foreign matter, making a closer and finer separation of the wheat, taking out any remaining oats, white caps, joints and seeds left over by the receiving separator. The light and imperfect wheat is drawn out by air current. From the separators the thoroughly cleaned wheat goes to the scourer which has a cylinder or series of blades of beaters revolving very rapidly, from 500 to 700 revolutions. These beaters throw the grain against the "case" which may be simply of heavy woven wire, the mesh or openings being small enough to prevent even the smallest berry from passing through, but allowing pieces of bran, chit or seed to be forced through, to settle in the hopper below, or to be drawn into the fan.

The effect of the beaters throwing the wheat against the rough casing at varying angles is to scour off the beards, exteriors dirt and, in case of severe scouring, the outside cuticle or woody covering, all this being forced through the openings of the case, with the beaters acting as blowing fans. In both cases of the separator and scourer, the wheat is subjected to a current of air or suction at the receiving end and again on leaving the machine; this takes out the lighter wheat and remaining dust. On their passage to the fan, the heavier grains are arrested when they get into the tips where the expanding air loses some of its force, and cannot carry them farther, so they fall of their own weight into what is called "the screening tips." In some mills wheat that contains a great deal of cockle seed is passed through a cockle-cylinder which removes seed more perfectly. Mills that use wheat containing a good deal of smut or contaminated by smut, wash the wheat in machines for that purpose, after which it is dried and again scoured and tempered before going to the rolls.

A modern roll called a "double stand" consists of two pairs, one on each side. If each pair handles different material as they do in smaller mills, a partition below the rolls practically makes each a distinct pair.

The rolls are carried on bearings, which are rigid for one roll and movable or free for the other, allowing this roll to be adjusted closer to or further apart from the other roll according to the fineness desired to break or crush the stock passing between the rolls.

The arms of the movable roll are pivoted below on eccentric bearings, one on each side of the roll frame. The tramming or bringing the rolls into level is accomplished by means of turning this eccentric bolt, and then locked by a nut, but the arm is allowed to move or swing freely as in adjusting the rolls or spreading them apart, by the lever, when shutting down or when the roll runs empty. The arm at the top carries a recess which contains a heavy coil spring, which bears against the inner closed end, and against the wheel at the outer end. The rod passing through is the adjusting or lighter, corresponding to that of the millstone. At the outer end is the hand wheel used to compress the spring and thus stiffen or increase the tension. The inner hand wheel is the adjustor. By turning the wheel left or right, or forward on the threaded rod, it permits the rolls to close up; turning it in the opposite direction, spreads the rolls apart. Passing through the centre under the feeder housing is a small shaft to which is attached a lever. There are two pairs of eccentrics on each end, to which are attached the adjusting rods by their yokes. The movement of the lever in one direction throws both the movable rolls from their mates simultaneously at both ends, and vice versa brings them back to position.

Each pair of rolls has a fast and slow roll. In order to grind or crush with effect, there must be more or less of a

rending or tearing action, and for this reason the rolls are given "differentials" in speed, the most common differentials used being 2½ to 1 for break rolls on wheat, to 1½ to 1¼ to 1 on the middling reduction rolls, which are smooth almost without exception, though very finely corrugated, or scratch rolls are sometimes used on the first clean middlings.

There are several types of bolters or sifters. The hexagon or six-sided reel is the oldest type of bolter still used, but its action in bolting is rather harsh. The round reel dresser is gentler in action, and like the hexagon, is slow in running, 30 revolutions being the mean. The centrifugal reel is used only on very soft, flaky material, for its disintegrating effect. The gyrating type of sifter is altogether considered to be the best and most gentle of all. The action of the gyrating sieves is to compel the stock to travel spirally on the surface of the flat sieve and on top of the silk, so as to bring the lighter, fluffier and impure parts on top of the travelling stream and hold them there until they tail off, the purer going through the cloth. Various means or devices are used to keep the meshes of the cloth open.

From there the wheat goes to purifiers. In the old flat grinding process all the flour possible was made at one and the first grinding. This system was very simple, consisting of a rolling screen, a smutter, a pair of burrs, one or two long reels, and a couple of elevators. Some middling or semolinas were made, but of such a character and containing so much fine bran or germs that when these middlings were reground on stone and bolted, it made an inferior flour as compared with the first, or superfine, produced in the grind of the wheat itself. The invention of a successful middlings purifier changed all that. From seeking to grind low, making no middlings, or as little as possible, it now became the object to grind higher, cut the bran as little, and make as much middlings as possible. The miller reduced the feed on the stone by half, bestowed more skill and patience in dressing the burr, giving smoother surfaces and grinding higher and cooler with a millstone; he thus produced middlings that after being purified and then ground separately on stones and bolted, made flour superior to the "first" or "clear" flour produced from the grinding of the wheat itself. This flour produced from the purified middlings was called "New Process" or "Patent" flour.

The different grades of middlings, after being purified, are crushed on the smooth rolls and then sent to the different sections of the sifter and sometimes to reels, as in the last roll reduction. With each reduction and subsequent separation of bolting, there is a certain amount of flour sifted out, and as a natural consequence there is an increased proportion of impurities to be handled on the next reduction and separation, so that the tendency is for the flour to be less white and clear, and partially to counteract this tendency it is necessary to have the cloths finer and finer. After certain reductions the tailings may be of such a nature as not to require further handling, and are sent direct to feed as finished, while those containing any floury parts are again reduced and sifted, the final results being flour, bran and shorts.

The paper contained also a detailed discussion of the capacity of machines and weights, and a description of the model mill to be built at Pennsylvania State College, State College, Pa., to give students the practical part of milling, and for experimental purposes in the way of testing the different kinds of wheat, to ascertain the bread making qualities of the flour; baking and chemical tests of flour and grain, and experimentation with various machines as to efficiency, power absorbed, etc.

BELTING INFORMATION.

The following, along with other valuable information, is taken from a catalogue and handbook published by the Fitz Water Wheel Co., manufacturers of the well-known I-X-L Overshoot Water Wheel, Hanover, Pa.:—

Rule for Calculating Length of Belting before Pulleys are Placed in Position.

Add together the diameter of the two pulleys and multiply the sum by 3.14159. To half of the result thus obtained add twice the distance from centre of one pulley (or shaft) to centre of the other pulley (or shaft).

Example.—Given the distance between centres of pulleys, 28 feet 8 inches; diameter of pulleys, 52 inches and 46 inches. What is length of belt?

52 + 46 = 98 × 3.14159 = 307.87 inches.
307.8 ÷ 2 = 153.98 inches ÷ 12 = 12.83 feet.
Centres 28 8-12 feet × 2 = 57.33 "

Answer 70⅙ feet.

Tightners.—The tightening pulley is applied to the belt to increase its adhesion to the pulley, and, as this is to fall first on the smaller pulley, it is usual to place it on the slack side of the belt near this pulley in order to increase the area of contact as well as adhesion. It also increases the friction of driving in proportion to the thrusting of the belt from the line of its natural curvature.

Horse-Power Transmitted by Leather Belts.

Speed in feet per minute.	Width of Belt in Inches.												
	2 H.P.	3 H.P.	4 H.P.	5 H.P.	6 H.P.	8 H.P.	10 H.P.	12 H.P.	14 H.P.	16 H.P.	18 H.P.	20 H.P.
400	1	1½	2	2½	3	4	5	6	7	8	9	10
600	1½	2¼	3	3¾	4½	6	7½	9	10½	12	13½	15
800	2	3	4	5	6	8	10	12	14	16	18	20
1,000	2½	3¾	5	6¼	7½	10	12½	15	17½	20	22½	25
1,200	3	4½	6	7½	9	12	15	18	21	24	27	30
1,500	3¾	5¾	7½	9½	11¼	15	18¾	22½	26½	30	33¾	37½
1,800	4½	6¾	9	11¼	13½	18	22½	27	31½	36	40½	45
2,000	5	7½	10	12½	15	20	25	30	35	40	45	50
2,400	6	9	12	15	18	24	30	36	42	48	54	60
2,800	7	10½	14	17½	21	28	35	42	49	56	63	70
3,000	7½	11¼	15	18¾	22½	30	37½	45	52½	60	67½	75
3,500	8¾	13	17½	22	26	35	44	52½	61	70	79	88
4,000	10	15	20	25	30	40	50	60	70	80	90	100
4,500	11¼	17	22½	28	34	45	57	69	78	90	102	114
5,000	12½	19	25	31	37½	50	62½	75	87½	100	112	125

Metallurgical Comment

T. R. LOUDON, B.A.Sc.

Correspondence and Discussion Invited

UTILIZATION OF SLAG HEAT.*

It has long been realized that in the operation of blast furnaces the usual practice of tapping the slag into ladles, and removing it in a molten state to the slag-tip, is extremely wasteful of heat. It has the further disadvantage of occupying all the available land in the vicinity of the furnaces and rendering it useless; whilst disposing of the slag in this manner becomes gradually more and more costly as the tips get higher and further away, and the surrounding land becomes more valuable for the housing of workmen, etc. This difficulty has been met to a small extent in some works by the introduction of slag-brick-making machinery, slag wool or silicate cotton plant, and crushing and granulating plant for cement or manure, but in all these processes the enormous quantity of heat contained in the slag is entirely wasted.

Various attempts have been made to utilize the heat of slag for raising steam, but owing to the rapidity with which slag scales over and ceases to part freely with its heat when exposed in trays passing through boiler flues, and the losses in transmission of heat through plates, only a very small portion of the total heat can be actually imparted to

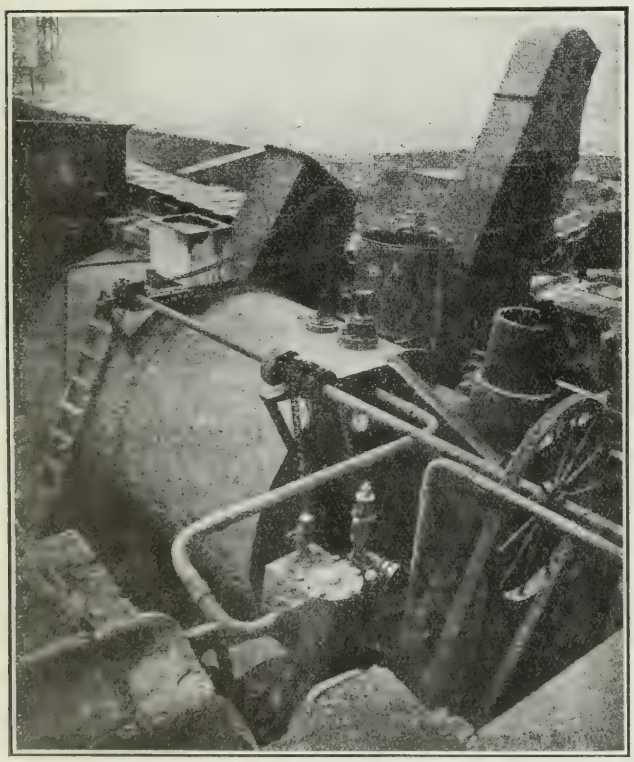


Fig. 1.—Experimental Plant for Utilization of Slag Heat.

the water in an ordinary boiler. In other designs where it has been attempted to take the slag hot or molten into the water, the formation of acids, due to the presence of air, has rendered the steam unfit for use for the generation of power, owing to the destructive effect of the acid on the boiler-plates and machinery; while the admission of air to the boiler makes condensing impracticable.

In the plant described and illustrated below, practically the whole of the heat in the slag is effectively imparted to the water in the boiler, and the exclusion of air from the boiler is a feature which not only prevents the formation of acid, but also allows of the steam generated being economically used in a low-pressure turbine, as the highest degree

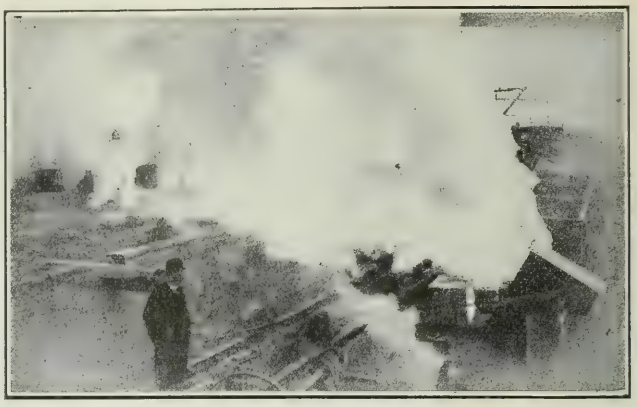


Fig. 2.—Plant in Operation.

of vacuum can be maintained at the condenser. The system is based on the Vautin patent, developed by Messrs. Slag Power, Limited, of 638 Salisbury House, London Wall, E.C. In dealing with slag from copper furnaces, the steam generated was found, on analysis, to be well suited for use in low-pressure steam turbines, and it was decided to ascertain whether the slag from blast furnaces could also be handled under the patent.

Fig. 1 illustrates the temporary experimental plant installed for this purpose at the ironworks of Sir B. Samuelson & Company, Limited, of Middlesbrough, and modified as required, and Fig. 2 shows the same plant at work, blowing steam to atmosphere through a 13-inch gate valve fully open, the pressure in the boiler being about 1 lb. above atmospheric pressure.

Chemical analyses have shown that no trace of sulphuric acid, or, in fact, of any kind, can be detected in the steam when condensed; that the amount of sulphuretted hydrogen is not sufficient to be harmful to the blades of a turbine, if made of sound and suitable metal; that the steam, though almost instantaneously generated, is superheated about 70 deg. Fahr., and that the quantity of steam generated from a furnace producing 1,800 tons of slag per week could safely be relied upon to develop 500 kilowatts of electric current per hour, with an expenditure of 6 h.p. for operating the plant.

The following figures may be taken as fairly representative of the quantities of the principal ingredients in a large number of samples of the granulated slag and condensed steam analyzed from time to time.

Slag.—Silica, 28.5 per cent.; alumina, 19 per cent.; lime, 36.4 per cent;. sulphur, 1.12 per cent.; iron, from 0.7 to 2.5 per cent.

Steam (in grains per gallon).—Chlorine, 0.4; total sulphur, 10; sulphuretted hydrogen, 3; acid, 0.

The corrosion of the shell of the boiler, after alternately working and being exposed to atmospheric influences for several months, is quite normal and uniform, showing no sign of pitting. A quantity of clean mild-steel drillings was placed in a sample of the condensed steam, and at the end of a fortnight the water was drained off and found, on test, to contain no trace of iron.

*Iron and Coal Trades Review.

In the "Vautin" system of working, air is excluded entirely from the boiler by means of a slag trap at the inlet and a head of water at the outlet. The elevator casing is made small in area, and the cold feed water is admitted at this point, to minimize the loss by evaporation, and the elevator push-plates are perforated to allow water to drain back into the boiler. Usually the most convenient arrangement is to install a separate boiler close to each furnace at the end of the slag road, the molten slag being led by a trough into the trap, and as it flows from same it is granulated in the steam space by a flat jet of the hot boiler water, circulated by a small centrifugal pump.

The elevator for removing the granulated slag is a combination of the push-plate and tray types, the trays being above the slag as it is pushed along the bottom of the boiler, to prevent any light material floating again after having been skimmed from the surface of the water. The granulated slag is removed from the end of boiler furthest away from the inlet, where it is taken up to a suitable height for discharging into a small storage hopper or direct into trucks.

About three minutes after slag is admitted, a cold boiler is steaming at full capacity, and the steam is led by a baffle-plate past the incoming slag to take up superheat. The working pressure is 1 to 1½ lbs. per sq. in. above atmospheric pressure (say 16 lbs. absolute), and the traps and elevator casings are designed so that no air is admitted unless the pressure is allowed to drop below 13½ lbs. per sq. in. absolute. The steam from each boiler is piped to the steam main, which supplies a low-pressure condensing steam turbine driving an electric generator.

Each boiler is fitted with two slag traps (one of which is a stand-by), and either of them can be emptied and made air-tight in a few minutes. There is a large body of slag in a molten state under the inlet to the boiler to prevent chilling, but prickers are also provided in case "nosing" is necessary. The traps are fitted with tapping holes and hinged bottoms for removal of the "skull" formed after a stoppage, the bottom doors being counter-balanced so that one man can easily operate them. The plate forming the bridge of the trap is quickly renewable and is a small, simple and cheap casting. The slag inlet to the boiler, which protects the boiler-plate, is also small and cheap, and is reversible before renewal.

The boiler illustrated was cylindrical, 8 ft. in diameter by 12 ft. long, but a flat-bottomed boiler about 6 ft. 6 in. wide and 10 ft. high is preferred. The power required to operate the granulating pump and the elevator is only about 1 per cent. of the power generated.

RAIL OUTPUT IN AMERICA, 1911.

According to statistics collected by the American Iron and Steel Association, and published in their "Bulletin," the production of all kinds of rails in the United States in 1911 amounted to 2,822,790 tons, as against 3,636,031 tons in 1910, a decrease of 813,241 tons, or over 22.3 per cent. Rails rolled from purchased blooms, crop ends, and "seconds," and re-rolled and renewed steel rails are included. Included in the total for 1911 are 205,409 tons of girder and high T steel rails for electric and street railways. The maximum production of all kinds of rails was reached in 1906, when 3,977,887 tons were rolled.

Bessemer Steel Rails.—The production of Bessemer steel rails in 1911 amounted to 1,138,633 tons, as against 1,884,442 tons in 1910, a decrease of 745,809 tons, or over 39.5 per cent. Of the total in 1911, 1,053,420 tons were rolled by makers of domestic ingots and 85,213 tons by companies which did not operate Bessemer converters. Included in the total by makers of ingots are 19,379 tons of re-rolled rails.

Open-Hearth Steel Rails.—The production of open-hearth steel rails in 1911 was 1,676,923 tons, as against 1,751,359 tons in 1910, a decrease of 74,436 tons, or over 4.2 per cent. Almost all the open-hearth rails in 1911 were rolled from basic steel and all were rolled by producers of open-hearth ingots.

Miscellaneous Rails.—A total of 7,234 tons of miscellaneous rails was rolled in 1911, including 234 tons of iron rails, 462 tons of rails rolled from electric steel, and 6,538 tons of re-rolled steel rails which the makers were unable to classify as Bessemer or open-hearth rails. Of the total production of steel rails in 1911, 2,708,795 tons were rolled from ingots made by the makers and 113,761 tons were rolled from purchased ingots or blooms, crop ends, "seconds," or renewed or re-rolled rails.

Weight of Rails.—The following table gives the production of all kinds of rails in 1911, according to the weight of the rails per yard. Girder and high T rails for street and electric railways are included.

Kind of rails.	Under 45 pounds. Tons.	45 pounds and less than 85 Tons.	85 pounds and over Tons.	Total. Tons.
Bessemer rails ...	111,231	606,300	421,102	1,138,633
Open-hearth rails.	100,755	461,387	1,114,781	1,676,923
Miscellaneous	6,772	9	453	7,234
Total in 1911 ..	218,758	1,067,696	1,536,336	2,822,790
Total in 1910 ..	260,709	1,275,339	2,099,983	3,636,031
Total in 1909 ..	255,726	1,024,856	1,743,263	3,023,845
Total in 1908 ..	183,869	687,632	1,049,514	1,921,015
Total in 1907 ..	295,838	1,569,985	1,767,831	3,633,654

OIL-FIRED OPEN-HEARTH FURNACE.*

E. Richarme.

The principal dimensions of the oil-fired furnace at Tsaritsyne are: Length of hearth, 14 ft.; width at the level of the burners, 6¼ ft.; mean height, 3½ ft.; air flue, 44 by 6 in.; slope, 30 degrees; slope of burners, 14 degrees. The bed is formed of two layers of magnesite bricks (the upper one laid on edge) covered with a layer of granular magnesite mixed with 25 per cent. of slag. The end wall is of magnesite bricks, and the front wall of magnesite brick below, and silica brick above. The injectors through which the petroleum residuum used as fuel is forced into the furnace, are arranged one on each side, and are sloped at a low angle to prevent the direct impact of the jets on the surface of the metal bath. The arch is made of large silica blocks.

The furnace was started working in April, 1907, and in November, after running 1,129 charges, was stopped for cleaning out the slag boxes. The end walls and door arches were repaired at a cost of 756 roubles (about £80), but the arch of the furnace and the chequer-work of the air chambers were still in good condition; in fact, both these portions of the plant lasted out a run of 1,694 charges before part of the arch collapsed. Examination then showed extensive corrosion of the arch, and both ends were corroded at the springings of the arch, the flues being also

* Revue de Metallurgie.

more or less eaten away. In the air chambers the upper layers of silica bricks were discovered to be fused, and about half the cells in the next layer were choked up, the rest of the chamber being in fairly good condition. The total cost of repairing these defective parts of the furnace and air chambers amounted to 2,113 roubles (£220). Up to the time of these repairs the furnace had been run for 591 shifts, or 1,694 charges (each of an average of 264 poods, or 4¼ tons), the net production per 24 hours being 1,432 poods (14 tons). The consumption of charging material included: Hematite pig, 172,651 poods (2,785 tons); scrap, 270,126 poods (4,357 tons); 80 per cent. ferro-manganese, 1,783 poods (29 tons); 50 per cent. ferro-silicon, 1,115 poods (18 tons); or 445,675 poods (7,189 tons) in all. To this must be added: Ore, 10,172 poods (164 tons); flux, 26,177 poods (422 tons); magnesite and dolomite, 4,921 poods (80 tons); and fuel, 57,998 poods (935 tons). The total production amounted to: Ingots, 387,053 poods (6,245 tns); molten steel for castings, 36,212 poods (584 tons); and waste in runners, gates, etc., 5,079 poods (82 tons), a grand total of 428,344 poods (6,911 tons).

Since that time the furnace, which has a capacity of about 4 tons, has been run continuously, with a stoppage for repairs once a year after an average run of 1,700 charges, and a mean cost for repairs of 0.7 copeck per pood (11d. per ton) of output. The consumption of fuel is 130 per cent., and since the heating value of this fuel is 11,200 cal., as compared with 7,300 cal. in the case of coal with 11 per cent. of ash, the foregoing consumption corresponds to one of 200 per cent. of coal.

The jet of oil fuel is directed toward the bath of metal at an angle of 14 degrees to the horizontal; a simultaneous examination of flame and furnace arch through smoked glasses shows that the arch is dark in comparison with the flame, and that there is a dark zone between the two; a circumstance which explains the long working life of the arch and also the large number of charges which can be worked in 24 hours. This arrangement of the flame so as to heat by contact with the charge is contrary to the theoretical recommendations of certain metallurgists, namely, that the heat should be reverberated from the arch of the furnace. As a matter of fact, the flame must be kept as far as possible away from the arch and as close as possible to the materials to be heated, in order that the arch may be protected from corrosion and the heating be effected with rapidity and economy.

The seven 20-ton furnaces worked on the same system at Tsaritsyne also act satisfactorily. The charges have the following composition per 1,000 parts of steel produced: Hematite pig 670; scrap iron 360; steel scrap 20; ferro-manganese (80 per cent.) 4, Krivoi-Rog ore 60; rolling-mill cinder 40. The consumption of petroleum for heating and smelting is 150 parts, corresponding to 230 per cent. of coal containing 11 per cent. of ash. All the materials of the charge are put in cold. These 20-ton furnaces run for 1,094 charges before any extensive repairs are needed. The diurnal output is over 60 tons each; that is to say, three charges per 24 hours, on the average of the year's run, with an occasional output of 80 tons, or four charges, per 24 hours.

REPRINT OF PROPERTIES OF METAL.

On page 606, May 2nd issue of *The Canadian Engineer* was printed a table of "Properties of Metals." As this will probably be of considerable use to draughtsmen and designers, we have reprinted the table on heavy mounted paper. Copies may be obtained free by addressing the Book Department, The Canadian Engineer.

GAS CIRCULATION IN ELECTRICAL REDUCTION FURNACES.*

By Jos. W. Richards.

Mr. J. A. Leffler's splendid report on the working of the Trollhättan furnace in the electrical reduction or iron ores, presented at the annual meeting of the Jernkontoret at Stockholm, Sweden, May 31, 1911, occupying over 200 pages of that Society's transactions, brings out more information as to the electrical reduction of iron ores than has ever before been available. The report has been discussed at length before this Society by Mr. T. D. Robertson (Volume XX, page 375), and also by Mr. Otto Frick, in Metallurgical and Chemical Engineering (December, 1911, page 631). A discussion of the results and of the devices employed brings into prominence the question of circulating the gases in such an electric shaft furnace, a device which has been employed by the Aktiebolaget Elektrometall for the last three years. The writer has some reflections to offer upon this subject, which may be preceded by a short discussion of the reasons for the adoption of this circulation.

Reasons for Circulating the Gases.—In the early working of the Domnarfvet furnace, the weakest point was the overheating of the roof of the crucible. To preserve this roof, Messrs. Groenwall, Lindblad and Stalhane conceived the idea of bringing from the top of the furnace some of the waste gases, and injecting them, comparatively cool, into the space beneath the arched roof of the crucible and charge beneath, so as to cool the under surface of the arch and thus preserve it from destruction. Later, some of this cool gas was also employed to pass through the bronze castings, forming jackets through which the electrodes passed, thus cooling them thoroughly and sending into the furnace the heat absorbed from them, instead of losing said heat in cooling water.

Incidentally to the use of cool waste gases, it was found that when these gases were thus returned into the crucible of the furnace, in amount equal or superior to the volume of gases being generated by the reduction of the ore, this additional volume of gas carried out of the crucible into the shaft of the furnace above a considerable amount of heat, thus prolonging upwards the hot zone of the furnace, and increasing considerably the amount of reduction of the ore by CO gas in the shaft of the furnace. Indeed, without this circulation of gases the amount of gases produced by the reduction alone in the crucible was insufficient to heat the shaft of the furnace to any considerable distance, thus rendering the shaft useless as a place of reduction of the ore by ascending gases. The circulation was then pushed to an extreme, such that two-thirds to three-fourths of all the gases passing out at the top of the furnace was returned to the crucible, and thus virtually the same gas passed two or three times through the charge; the effect of this increased circulation was a pronounced economy and advantage, viz., increased heating of the shaft by the carrying upwards into it of surplus heat from the crucible, that is, a better distribution of the crucible heat upwards into the shaft of the furnace, and finally a better ratio of CO_2 to CO in the furnace shaft gases, showing that much reduction of ore has been accomplished by CO gas in the upper part of the furnace, and thus the ultimate goal of better utilization of carbon in the furnace was attained.

The writer is convinced, however, that these advantages are offset by serious disadvantages. The most obvious dis-

*Presented at the recent meeting of the Am. Electro-Chem. Soc.

advantage is that the moisture of the charges and the CO_2 of the flux and the CO_2 gas naturally produced in the furnace are returned in large part to the crucible, and there act upon the unconsumed carbon, by the reactions.

$$CO_2 + C = 2CO$$
$$H_2O + C = H_2 + CO$$

This very materially cools the smelting zone of the furnace, its most vital working part. The constructors and operators of these furnaces have recently introduced dust-catchers to intercept fine dust carried out at the top of the furnace by the gases, and also scrubbers, where the circulating gas is cooled, washed, and made to deposit this excess of water before passing into the crucible of the furnace. This device certainly removes the dust and most of the water of the gases, but cannot remove the CO_2 which it is the aim of the circulating process to increase to as high a percentage as possible and thus economize the carbon of the furnace. It stands to reason, therefore, that the better the circulating system works in facilitating reduction in the furnace, that is, in producing more CO_2 in the gases, the more prejudicial will be the introducing of the gases into the crucible of the furnace produced by the chemical reduction of this CO_2 to CO. Besides, the circulating system is cumbersome and expensive, and soon reaches the maximum of useful effect; in the writer's opinion it is an imperfect solution of the difficulties of the furnace. Considering merely the reduction of the ore by CO gas in the shaft of the furnace, it is a question of temperature and time, and to a lesser extent of the amount of CO gas passing. The reduction in the crucible undoubtedly produces CO gas, which, rising upwards slowly through the charge, will have the very best opportunity of producing the maximum amount of CO_2 if it slowly filters upwards through the shaft and there has ore at a low red heat to act upon. If it were possible to keep the column of ore in the shaft of the furnace at a low red heat it is certain that the CO gas would perform the maximum amount of reduction possible, and pass out one-half or two-thirds converted into CO_2, thus consuming the theoretical minimum amount of carbon for reduction in the furnace. The critical point of this analysis is that the ore in the shaft and furnace cannot be maintained at a red heat by the ascending of the gas naturally produced by reduction of the ore; it is insufficient in amount. It follows that the reduction is facilitated either by maintaining the ore red hot by other means, or by circulating the gases two or three times through the ore, thus keeping the materials in the shaft at the reducing temperature. The latter scheme has been the only one adopted, and has been effective, but the extent of its advantages is largely self-limiting, as has been already explained. It is quite evident that when the amount of gas passing through the furnace is increased two or three times, its velocity is increased two or three times, and therefore it is in contact with the ore only one-half to one-third as long. Theoretically this would mean that there would be no increased reduction by CO, except because of the higher temperature produced in the shaft by the increased volume of circulating gas increasing the velocity of the reduction reaction. The consideration of these circumstances leads to the following proposition.

Modified Working.—The writer thinks that the circulation of the gases should be entirely dispensed with, thus simplifying very greatly the operation of the furnace and regularity of its running. If this were done, means should be provided to preserve the arch of the crucible other than by injection of cool gas beneath it. I believe that the present experience of furnace men in preserving arches, ports and bridges of open-hearth furnaces by means of water-cooled plates embedded in the brick-work can be made to conserve the form of the arch of the crucible satisfactorily, thus dispensing with the necessity of introducing cool gas for this purpose. Then, having gotten away from the circulation of the gas, and the furnace again started in its original path, we can reduce the ore in the crucible by carbon and allow only the CO gas there produced to filter slowly through the charge in the shaft of the furnace.

In order that the ore in the shaft of the furnace may be reduced by gas it will be necessary to adopt other means of keeping the charge in the shaft of the furnace at a temperature above, say, 400° Centigrade. This can be done by means of auxiliary electric energy, and also conceivably by jacketing the shaft and burning the waste furnace gas around it.

I therefore suggest that the material in the shaft of the furnace be heated by the waste gases of the furnace burnt in flues around it, or by electric current passed through it from surface electrodes embedded in the walls of the shaft, at a point near the middle of the shaft, sufficient current being passed through the charge to heat it by its own resistance to a red heat. This will give the up-rising CO gas the maximum opportunity of reducing Fe_2O_3 and attaining equilibrium. In this way I believe that the following reaction can be attained,

$$5Fe_2O_3 + 9C = 6CO_2 + 3CO + 10Fe$$

representing the maximum formation of CO_2 by reduction in a slow current of CO. The above reaction requires only 200 parts of carbon per 1,000 or iron reduced, which is much better than can possibly be attained by the present circulating system.

As above given, the reaction is based upon dispensing with the CO_2 of the limestone; that is, the limestone should be calcined outside of the furnace (which could also be done by waste gas of the furnace itself). This saves carbon by avoiding the evolution of CO_2 from carbonates in the lower part of the furnace, below the zone of reduction by CO gas, but where CO_2 is reduced to CO by solid carbon.

Conclusions.—(1) The arch of the crucible of the furnace should be protected by water-cooled plates, as is common in open-hearth furnaces.

(2) The artificial circulation of the gas in the furnace should be dispensed with.

(3) The limestone flux should be calcined before putting into the furnace.

(4) The shaft of the furnace should be provided with auxiliary heating to maintain its contents at or above 400° Centigrade, to permit of reduction of Fe_2O_3 by the slow current of CO gas.

(5) Under these conditions an amount of carbon equal to one-fifth of the weight of iron produced should be sufficient, producing gas containing two volumes of CO_2 to one of CO.

(6) Eliminating the expense of circulating and purifying the gas, and reducing the amount of fuel required for reduction, would both simplify and cheapen the operation of the furnace.

CORRECTION.

In the April 25th issue of *The Canadian Engineer*, on page 510, an article by Mr. Ed. S. Bryant on "Foresting" was credited to the Boston Society of Civil Engineers. This article was read before the New England Waterworks' Association.

A NEW HYDRAULIC TURBINE.

A description of the hydraulic turbines of the Société anonyme des Ateliers de Construction de Th. Bell et Cie de Kriens (Lucerne, Switzerland), is given in L'Industria. An abstract of the article appears in the April Journal of the American Society of Mechanical Engineers. The turbine is of the Francis type. The regulator is shown in Fig. 1. The oil under pressure is driven from the reservoir B by a pump, driven by the pulley S, to the valve gear V, which communicates with the cylinder chambers C_1 and C_2 by the ducts K_1 and K_2, and with the reservoir B by the duct K_3. The valve gear is regulated by the spring governor R in such a way that the pressure acting on one side of the piston

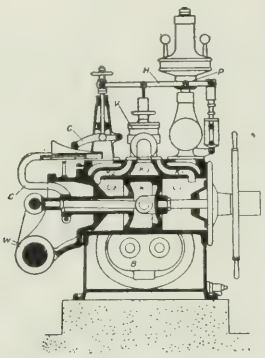


Fig. 1.—Oil Regulator in the Bell Water Turbine.

K varies according to the conditions of work of the turbine, and produces displacements of the piston which are transmitted to the governor spindle. To decrease the stroke of the piston, and to prevent excessive opening and closing of the turbine, the gear rod G is provided to bring the valve into its middle position, so that when the number of revolutions of the turbine is constant, the pump works as if there were no pressure, and it had only to make the oil circulate, thus making the consumption of power very slight.

PERSONALS.

Mr. Murray D. Kennedy has been appointed manager of the Beacon Mines at Elk Lake, Ont.

Mr. Robert Potter, B.Sc., of Fernie, B.C., has been appointed to the position of city engineer of Regina, Sask.

Mr. L. A. Thornton has been appointed to the office of a city commissioner for the municipality of Regina, Sask.

Mr. Arthur B. Lee has received the appointment of secretary-treasurer of the Woodstock Water and Light Commission.

Mr. F. M. Radford, of Sidney, has been appointed assistant to the Commissioner of the Geodetic Surveys of Canada.

Mr. E. F. Bradley, of the Canadian General Electric Company, has been appointed sales-manager of the Canada Wire & Cable Co., Ltd.

Mr. Edward Henry Keating, consulting engineer, and a former city engineer of Toronto, has been elected to the Council of Institution of Civil Engineers of Great Britain.

Mr. Mellis Ferguson, of Stratford, has been appointed city engineer of Guelph, at a salary of $2,000 a year. Mr. Ferguson has been town engineer of Stratford for the past few years.

Mr. H. A. Brazier has been appointed to the position of assistant city engineer for the municipality of London, Ont. Mr. Brazier has been for some time employed in the engineering department of the city of Toronto.

Mr. Carl I. Printz has opened offices in Toronto as a Consulting, designing and inspection engineer. His office address will be 127 Delaware Avenue, He will take over the Ontario business of Messrs. Escher, Wyss & Company.

Mr. R. L. Werry has been appointed secretary-treasurer of the Montreal Builder's Exchange. Up to the present Mr. Werry has been engaged in newspaper work and has had especial opportunities of keeping in touch with interests that will be found of value in his new position.

Mr. R. H. Parsons has been appointed superintendent of the municipal power plant at Edmonton, Alta. Mr. Parsons recently completed a hurried trip across the Atlantic in order that the position should not remain unoccupied long, owing to the resignation of Mr. Huffman.

Mr. Geo. C. MacLennan, S.P.S., '10, has been appointed resident engineer for Messrs. Mitchell & Mitchell, consulting engineers, Toronto, on power development at Minnedosa, Man. Mr. MacLennan has just completed his post-graduate course at the University of Toronto.

Mr. H. T. Routley, O.L.S., D.L.S., of the firm of Routley, Summers & Malcolmson, Haileybury, Ont., was recently elected to the presidency at the Board of Trade at that town. Mr. Routley is engineer for the township of Coleman, which is the richest township in the Dominion.

OBITUARIES.

The list of men, prominent in the public life of Canada, who have been recently called by the hand of death has been added to by the sudden death of **James Pitt Mabee,** late chief commissioner of the Board of Railway Commissioners for the Dominion of Canada.

His death resulted from an attack of appendicitis, and occurred in St. Michael's Hospital, Toronto, on Monday, May 6th, last.

The late Judge Mabee was born in 1859 at Port Rowan in Norfolk county, Ont. He was educated at the Port Rowan High School, and, graduating at the age of eighteen, went into the study of law. He was called to the Bar when but twenty-three years of age, and for five years practised in Listowel. From Listowel the young man moved to Stratford, where he practised for eighteen years. It was from here he began to assume the duties which doubtless hastened his end, and Chairman Mabee proved himself to be capable of the big work before him. To be chairman of a body that has jurisdiction over some twenty-five thousand miles of railway reaching over half a continent was a work which had no parallel in any other country. In this capacity he had to exercise all the powers of analysis that made him a big lawyer and a strong judge; all the patience and tenacity that make a master mind in dealing with evidence. And Chairman Mabee became the biggest unelected public man in Canada.

The deceased leaves a son, Lionel, with the National Trust Company, Toronto, and a daughter, Mabel, at home. Mr. O. H. Mabee, of the Manufacturers' Life Insurance Company, is a brother of the deceased.

The Canadian Pacific Railway have recently lost a valued and trusted official in the person of **Mr. James Oborne.** His death occurred in Vancouver, B.C., on Tuesday, April 30th, from erysipelas. Mr. Oborne was for some time superintendent of this railway at Toronto, but had been recently appointed General Superintendent of the Pacific Division. He was born in Montreal fifty-five years ago and entered the offices of the mechanical superintendent of the Grand Trunk Railway when about fourteen years

old. In 1883 he joined the staff of the Canadian Pacific Railway as chief mechanical clerk. In 1886 Mr. Thomas G. Shaughnessy, then general manager, appointed James Oborne his chief clerk. He held his position for sixteen months. In September, 1887, he was made car accountant, and in 1890 superintendent of car service. In 1892 Mr. Oborne was appointed general fuel agent. Four years later he was made assistant to the vice-president, and his tenure of office continued for three years. Following this office, Mr. Oborne got his first appointment as a division superintendent. He was sent to Winnipeg to supervise the affairs of the division, which then extended from Port Arthur to Laggan, B.C. In 1901 he was transferred to the superintendency of the Atlantic division, with headquarters at St. John, N.B. After two years he was appointed general superintendent of the eastern division, with headquarters at Montreal. Then, in December, 1906, Mr. Oborne was appointed general superintendent of the Ontario division, with headquarters in this city. He held this position until two months ago, when he exchanged the Ontario superintendency for that of the Pacific Coast.

COMING MEETINGS.

AMERICAN RAILWAY ASSOCIATION.—May 15th. Semi-Annual meetlng at New York City. Sec'y, W. F. Allen, 75 Church St., New York.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—May 22nd-25th. Annual Convention at Chicago, Ill. Secy., D. B. Sebastian, La Salle St. station, Chicago.

FOURTH NATIONAL CONFERENCE ON CITY PLANNING.—May 27th-29th. Meeting, Public Library, Boston, Mass. Sec'y, Flavel Shurtleff, 19 Congress Street, Boston, Mass.

AMERICAN WATER WORKS ASSOCIATION.—June 3rd-8th. Annual Convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N.Y.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithica, N.Y.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President, J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
5-10	One diesel oil engine, Vernon, B.C. ....(S.)	4-25
5-15	Reinforced arch bridge, Guelph, Ont...(P. & S.)	5-2
5-29	—Water works, sewerage and electric light systems, Melfort, Sask. ....(P. & S.)	5-2

(Melfort plans and specifications are also on file at The Canadian Engineer Offices, 820 Union Bank Building, Winnipeg, and B33, Board of Trade Building, Montreal).

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Arkona, Ont., church	May 10.	May 2.	59
Australia, steel rails and fish plates	May 29.	May 2.	60
Calgary, Alta., timber structures	May 15.	Apr. 18.	76
Cobourg, Ont., sewage disposal works	May 14.	May 2.	74
Exeter, Ont., sewer pipe	May 10.	Apr. 25.	72
Fort William, Ont., garbage incinerator	May 15.	Apr. 18.	74
Fredericton, N.B., culvert	May 20.	May 2.	60
Guelph, Ont., Masonic temple	May 8.	May 2.	59
Guelph, Ont., bridge	May 15.	May 2.	72
Hamilton, Ont., public comfort station	May 9.	May 2.	59
Hamilton, Ont., castings, meters, etc.	May 30.	May 2.	72
Lebret, Sask., school house	May 31.	Apr. 25.	61
Moose Jaw, Sask., paving	May 15.	Apr. 25.	72
Melfort, Sask., waterworks, sewerage, etc.	May 29.	May 2.	72
North Battleford, Sask., boiler, steam engine, etc.	May 15.	May 2.	60
Ottawa, Ont., dredging	May 13.	May 2.	60
Ottawa, Ont., dredging	May 15.	May 2.	60
Owen Sound, Ont., concrete dam	May 13.	May 2.	60
Ottawa, Ont., pumping machinery	May 14.	Apr. 25.	70
Ottawa, Ont., dredging	May 13.	Apr. 25.	62
Ottawa, Ont., steel tug	Apr. 22.	Apr. 11.	60
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., fishing protection vessel	June 17.	Apr. 18.	74
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Quebec, Que., leasing of water-powers	June 26.	May 2.	72
Regina, Sask., electric supplies, Sec. 6 to 9	May 15.	Apr. 11.	72
Saskatoon, Sask., garbage incinerator	June 25.	May 2.	74
Saskatoon, Sask., superstructure 23rd Street subway	May 17.	Apr. 18.	76
Sault Ste. Marie, Ont., widening lower entrance channelway	May 10.	Apr. 18.	60
Vancouver, B.C., water pipe and gate valves	May 15.	Apr. 25.	62
Varna, Ont., drainage work	May 15.	Apr. 25.	62
Vernon, B.C., diesel oil engine	May 10.	Apr. 25.	72
Wallaceburg, Ont., public building	May 13.	May 2.	60
Winnipeg, Man., electric locomotive, etc.	May 15.	May 2.	60

TENDERS.

Aylmer, Ont.—Tenders for the several trades in connection with the erection of a Carnegie Free Library at Aylmer, will be received up to May 15th, 1912. Plans, etc., at the office of the architect, W. A. Mahoney, Telephone Building, Guelph, or at the Molsons Bank, Aylmer. D. N. McGregor, Secretary, Aylmer Library Board.

Edmonds, B.C.—Tenders for the construction of a concrete covered reservoir on the Royal Oak Road, in D. L. 158, will be received up to Monday, May 20th, 1912, at the office of W. Griffiths, Comptroller, Edmonds. Particulars may be obtained at the office of the engineers, Cleveland & Cameron, 506 Winch Bldg., Vancouver.

Lunenburg, N.S.—Tenders will be received by Geo. H. Love, Town Clerk, Lunenburg, up to June 1st, 1912, for the construction of a system of sewerage for the town, in accordance with the terms of a report, plans, and specifications furnished to the town by Snow & Barbour, Civil Engineers, and now on file at the Town Office.

Minnedosa, Man.—Tenders for the construction of the spillway, intake, penstocks and power-house foundations of the Minnedosa Power Company, will be received up to May 10th, 1912, at the office of H. F. Maulson, Secretary of the Minnedosa Power Company, Minnedosa, Man. Plans and specifications may be seen at the office of W. Sanford Evans & Company, Grain Exchange Building, Winnipeg, and at the office of F. G. Taylor, barrister, Portage la Prairie, and at the offices of the company at Minnedosa.

Montreal, Que.—Tenders will be received up to noon of Monday, May 20th, 1912, for the demolition of old buildings and the erection of the Montreal City Hall Annex, in Gosford, Champ de Mars and St. Louis Streets. Plans, etc., may be seen at the office of Messrs. Marchand & Haskell, architects, No. 164 St. James St., city. L. N. Senecal, secretary, Board of Commissioners' Office, City Hall, Montreal.

Moose Jaw, Sask.—Tenders will be received until May 15th, for all the works required and necessary in connection with the erection and completion of a brick and stone church building for St. Andrew's congregation at Moose Jaw, Sask. Plans, etc., at the office of T. J. McCammon, Secretary Board of Managers, 57 River Street West, Moose Jaw, or to J. H. G. Russell, architect, Winnipeg.

Ottawa, Ont.—The Department of Public Works will receive tenders up to 4 p.m., on Thursday, May 23, 1912, for the construction of a wharf at Upper Maugerville, Sunbury County, N.B. Plans and specifications with J. K. Scammell, Esq., District Engineer, St. John, N.B.; the Postmaster at Upper Maugerville, Sunbury County, N.B.; and the Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until May 13th, 1912, for dredging required at Maquapit Lake, N.B. Full particulars at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the construction of a breakwater at Trout Cove, Digby County, N.S., will be received by the Secretary, Department of Public Works, Ottawa, until May 23rd, 1912. Plans, specifications, etc., can be seen at

Barrett Specification Roofs

A CONCRETE CITY

Covered with Barrett Specification Roofs

IN the illustration below the Turner Construction Company, of New York, has brought together in a scale drawing an accurate representation of most of the important modern concrete buildings which they have erected during the past nine years, at an approximate cost of $12,000,000.

It is an imposing display of best types of modern construction—"*a concrete city*" indeed—scientifically designed for maximum service at minimum cost and minimum maintenance.

In the use of concrete, the designers of these buildings planned for economy—the real economy that results from adequate strength and no repairs.

Barrett Specification Roofs are a *real economy*, and it is significant that 95 per cent. of the entire roof area is covered with this type of roofing. The figures are as follows:

Barrett Specification type of Roofs	1,490,523 sq. feet
Plastic Roofings	14,714 sq. feet
Slate Roofings	21,640 sq. feet
Tile Roofings	5,619 sq. feet
Ready Roofings	38,381 sq. feet
Copper Roofings	6,355 sq. feet
All other kinds	7,448 sq. feet

It is important to remember that while all these buildings were constructed by the Turner Construction Company, the specifications were drawn by a large number of architects and engineers. That the great majority of these specified a Barrett Specification type of roof, emphasizes the fact that whenever this roof is practicable the best modern engineering practice will have no other kind.

These roofs were selected for one reason only, namely, that they would give *better* service at *lower cost*, than any other roof covering.

Barrett Specification Roofs require no painting or similar attention—in other words, there are no maintenance costs. They will last upwards of 20 years without any care.

That the above statement is conservative may be realized from the fact that roofs of this type have lasted, without attention, for thirty-five years, and are still in serviceable condition.

The superior economy of Barrett Specification Roofs justifies their adoption not only on big first-class concrete buildings, but on every flat roofed building from a tenement to a skyscraper—from a small mill to a modern manufacturing plant costing millions—but be sure it's a real Barrett Specification Roof—and the only way to be sure is to incorporate The Barrett Specification in full in your plans.

Copy of The Barrett Specification with diagrams free on request. Address our nearest office.

The Paterson Manufacturing Co., Limited

Montreal Toronto Winnipeg Vancouver St. John, N.B. Halifax, N.S.

this department and at the offices of C. E. W. Dodwell, Esq., District Engineer, Halifax, N.S.; E. T. P. Shewen, Esq., District Engineer, St. John, N.B.; and on application to the Postmasters at Yarmouth, N.S., and at Centreville, (Trout Cove), N.S.

Ottawa, Ont.—The time for receiving tenders for widening the Lower Entrance Channel-way, Sault Ste. Marie Canal, advertised to be in on Friday, May 10th, 1912, is extended to 16 o'clock on Monday, May 20th. L. K. Jones, Secretary, Department of Railways and Canals, Ottawa.

Ottawa, Ont.—Tenders will be received by P. E. Ryan, secretary, the Commissioners of the Transcontinental Railway, Ottawa, up to noon of May 31st, 1912, for 200-ton mechanical coaling plants with sand houses and track approaches; also, 1,000-ton coaling station with the inclined trestle approach. Plans and specifications may be seen at the office of Mr. W. J. Press, Mechanical Engineer, Ottawa. (See advt. in Canadian Engineer).

Ottawa, Ont.—Tenders will be received up to noon of May 31st, 1912, for the erection of station and other buildings required along the line of the Transcontinental Railway. Plans and specifications may be seen at the office of Mr. Gordon Grant, Chief Engineer, Ottawa. (See advt. in Canadian Engineer).

Ottawa, Ont.—R. C. Desrochers, Secretary, Department of Public Works, Ottawa, will receive tenders until May 13th, 1912, for dredging required at the following places in the Province of Ontario,—Goderich, Napanee, Picton, Telegraph and Nigger Islands. (See advt. in Canadian Engineer).

Ottawa, Ont.—Tenders will be received at the Department of Public Works, Ottawa, until Wednesday, May 15th, 1912, for the hull repairs and renewals on the C.G.S. "Tyrian." Specifications, etc., may be obtained at the office of the Department, and at the office of C. E. W. Dodwell, Esq., District Engineer, Halifax, N.S.

Ottawa, Ont.—Separate sealed tenders will be received at the office of L. K. Jones, Secretary, Department of Railways and Canals, until May 16th, 1912, for the construction (1) of a brick and stone passenger station at Chatham, N.B., and (2) of a standard (wooden) passenger station and dwelling at Nelson, N.B. Plans, etc., at the office of the Chief Engineer of the Department of Railways and Canals, Ottawa; at the office of the Chief Engineers of the Intercolonial Railway, Moncton, N.B., and also at the station master's offices at Chatham and Nelson for the respective buildings at those places.

Ottawa, Ont.—The Department of Public Works, Ottawa, will receive tenders until Monday, May 20th, 1912, for dredging required at Sault Ste. Marie, Ont. Specifications, etc., at the office of the Department of Public Works.

Province of Saskatchewan.—Tenders for the erection of the following bridges in this province will be called for in a few days from the offices of the Board of Highway Commissioners:—

North-west of Asquith, over Eagle Creek, span 100 feet.
South of Estevan, over Souris River, span 100 ft.
East of Davidson, over Arm River, span 100 ft.
West of Battleford, over Battle River, span 250 feet.
North of Melfort, over Melfort Creek, span 60 ft.
South of Maple Creek, over Maple Creek, span 60 ft.
South of Drinkwater, over Moose Jaw Creek, span 150 ft.
North of Veregin, over Assiniboine River, span 125 ft.
West of Gorlitz, over Whitesand River, span 80 ft.
West of Lumsden, over Wascana Creek, span 80 ft.
West of Sturgis, over Assiniboine River, span 80 ft.
South of Webb, over Swift Current Creek, span 120 ft.

Sault Ste. Marie, Ont.—Tenders for supplying and laying about 21,000 lineal feet of tile sewer pipe with appurtenances, will be received until May 27th, 1912. C. J. Pim, City Clerk; W. W. Van Every, City Engineer. (See advt. in Canadian Engineer).

Sault Ste. Marie, Ont.—Tenders will be received until May 27th, 1912, for the construction of about 169,000 square feet of cement concrete sidewalks and about 21,000 lineal feet of concrete curbing. C. J. Pim, City Clerk; W. W. Van Every, City Engineer. (See advt. in Canadian Engineer).

Toronto, Ont.—Tenders will be received up to noon of May 17th, 1912, for sewer work on Walpole St., McKinley St., Tyrrell St., Davenport Rd., and Oxford St., plans and specifications of which may be seen at City Engineer's office, City Hall. Mayor Geary, Chairman, Board of Control, Toronto.

Toronto, Ont.—Tenders will be received at the office of Frank Barber, Civil Engineer, 57 Adelaide St. E., Toronto, at which place plans and specifications may be seen, for the construction of concrete abutments for a steel bridge 40 ft. clear span, and also for a reinforced concrete truss bridge, 60 ft. clear span and abutments. (See advt. in Canadian Engineer).

Vancouver, B.C.—Tenders for the grading and bridging of the first 10 miles of the Comox extension of the E. & N. Railway, from McBride Junction to Courtenay, will be received, addressed to H. J. Cambie, Chief Engineer, Vancouver, up to May 15th, 1912. Plans, etc., can be seen at the office of R. A. Bainbridge, Divisional Engineer of the E. & N. Railway, Store Street, Victoria. R. Marpole, Vice-President.

Vancouver, B.C.—Tenders will be received up to noon of May 31st, 1912, for the grading, bridging, etc., of the following sections of the Howe Sound & Northern Railway: (a) From end of present constructed line to mile 12.0. (b) From mile 12 to mile 24.1. (c) Branch from mile 2.3 of main line along east branch of Squamish River, 2.7 miles. Plans and specifications may be seen at the office of the Engineers, Messrs. Cleveland & Cameron, 506 Winch Building, Vancouver. Howe Sound & Northern Railway Company, 506 Carter-Cotton Building, Vancouver.

Victoria, B.C.—Tenders for the erection and completion of a four-room school building to be erected on the corner of Cecilia Road and Oliver Avenue, will be received at the office of the Board of School Trustees on or before Wednesday, May 15th, 1912. Drawings, and specifications may be seen at the office of C. Elwood Watkins, architect, Victoria.

Winnipeg, Man.—Tenders will be received by the Chairman, Board of Control, up to noon, May 16th, 1912, for the whole or any portion of the work of repairing the Salter Street overhead bridge. Specifications, etc., at the office of the City Engineer, 233 James Avenue. M. Peterson, secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received addressed to H. N. Ruttan, Consulting Engineer, Fort Garry Court, Winnipeg, until May 15th, 1912, for the construction of four miles of pipe sewer in Tuxedo Park, Municipality of Assiniboia.

N. H. Ruttan will also receive tenders until May 15th, 1912. for: 1,400 feet eight-inch, 3,600 ft. nine-inch, and 14,000 ft. of twelve-inch sewer pipe for Tuxedo Park Sewer System. Specifications may be seen at the Consulting Engineer's office.

CONTRACTS AWARDED.

Berlin, Ont.—The municipal councillors have accepted the tender of Messrs. Escher Wyss and Company, for the supply of two turbine pumps with a capacity of 500,000 gallons per day. The Canadian Westinghouse Company will supply the 75 horse-power induction motors for the operation of the above.

Calgary, Alta.—Harold Harvie, Calgary representative of the Canadian Mineral Rubber Company, received word from H. Rowstron, manager of the company, that they have just been awarded a contract for 100,000 yards of asphaltic concrete by the city of Vancouver.

Edmonton, Alta.—Messrs. W. Manders & Co., of Winnipeg, have been awarded the contract for 4½ miles of paving, 20 ft. wide, to cost $160,000.

Grandview, Ont.—Messrs. Schultz Bros., of Brantford, Ont., have secured the contract for the erection of a schoolhouse at Grandview, to cost $33,900.

Hamilton, Ont.—The city council have awarded the following contracts:—That of J. W. Danforth and Company, of Buffalo, for laying the waterworks conduit from the beach pump house to the filtering basins, and the laying of the intake pipe in the lake, for the bulk sum of $61,500. That of Drummond, McCall Company, for one 36-inch gate valve, $500, and four 30-inch at $290 each, for the beach pump house. The Canadian Foundry Company two valves, $725. The Darling Pump Manufacturing Company, two valves, $347. The Coffin Valve Company, for four swing valves, $950.50.

Hamilton, Ont.—Contract has been awarded to the Canada Wire & Iron Goods Co., 182 King William Street, Hamilton for heavy screens for the reformatory at Guelph, Ontario.

48 in. CONTINUOUS STAVE LINE.

Manufacturer of

Galvanized Wire Machine Banded

WOOD STAVE PIPE

CONTINUOUS STAVE PIPE

RESERVOIR TANKS

For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

Full particulars and estimates furnished.

PACIFIC COAST PIPE COMPANY, LTD.

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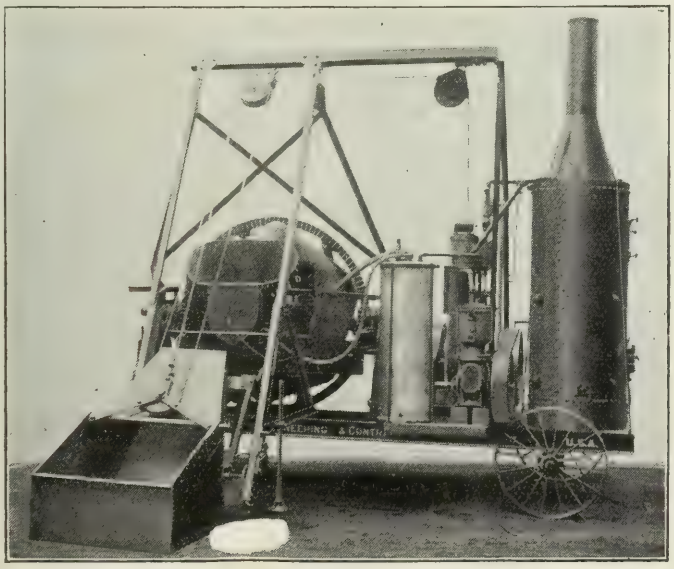
An Austin Improved Cube Mixer



The cube principle of mixing produces the most perfect concrete that can be mixed.

mixes by means of the shape of the drum, which is such as repeatedly to fold the batch as a unit right and left and forward on itself, and squeeze it as a unit into different shapes. **The cube principle is unit incorporation and contact under pressure.** A mixer with inside disintegrators mixes by means of shelves or paddles, which repeatedly break up and toss about the batch in small portions. **The inside disintegrator principle is piecemeal, separation and readjustment.** A study of the two principles of action shows why the cube mixer remains after thirty years the leading concrete mixer on the market.

The Austin Heating Attachment added to the Improved Cube Mixer is a Two-in-One Proposition which means plant economy. It does not interfere in the slightest degree with the Cube Principle of Mixing. It simply makes hot the materials being mixed. No more men are needed than for ordinary concrete mixing. There is no shifting of dampers, no feeding of the fire, no extra manipulation whatever to reduce the speed and mixing accuracy of the machine.

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CANADIAN EQUIPMENT & SUPPLY CO. Calgary and Vancouver—Agents for Western Canada.

LECKY & COLLIS, Napanee, Ontario, Agents for Eastern Canada.

(AGENTS WANTED IN OPEN TERRITORY.)

High River, Alta.—Contracts for the different branches of the work and the furnishing of materials for the installation of a system of waterworks and sewerage, estimated to cost $125,000, have been awarded as follows:

Contract A—All labor and certain materials necessary for laying water mains and sewers. Tenders: J. A. Broley and Co., Fernie, $27,755.60; Geo. W. Kemper, Minot, N.D., $42,951.25. Awarded to Broley and Co.

Contract C—Furnishing all materials for and erecting steel water tower, capacity 160,000 gallons. Tenders: William Hamilton Co., Peterboro, $8,060; John Inglis Co., Toronto, $8,150; Canadian Fairbanks-Morse Co., $8,436; Canada Foundry Co., $8,990; Chicago Bridge and Iron Works, $8,300. Awarded to John Inglis Co., Toronto.

Contract D—Furnishing cast iron water pipe, 422 tons, and special castings, 10 tons. Tenders: Stewart and Lloyds, Scotland Steel pipe, $17,166; Canada Foundry Co., $19,992.40; Gartshore, Thompson Co. of Hamilton, $20,725.60; Canadian Iron Works, Philadelphia, $25,638.40; Stavely Coal and Iron Co., England, $21,232.26; Canada Iron Corporation, Fort William, $21,006. Awarded to Canada Foundry Co.

Contract E—Furnishing fire hydrants, sprinkling cranes, gate valves and valve boxes. Tenders: Florence Iron Co., $3,706.25; Drummond and McCall, Montreal, $4,552.15; Roe Stevens and Co., $4,228.58; McAvity and Sons, Winnipeg, $3,469.35; Calgary Iron Works, $4,068.55; Canada Foundry Co., $4,384.70; Kerr Engine Co., Walkerville, $4,518.70. Awarded to McAvity and Sons, subject to approval of their style of hydrant by the engineers.

Contract O—All labor necessary for laying main sewer outfall. Tenders: J. A. Broley and Co., $2,940; Geo. W. Kemper, $3,780. Awarded to Broley and Co.

Contract S—Furnishing and delivering sewer pipe connections. Tenders: Red Wing Sewer Pipe Co., glaze tile, $7,092.90; Alberta Sewer Pipe Co., cement pipe, $5,956.50; American Sewer Pipe Co., glazed tile, $6,984.90. Awarded to American Sewer Pipe Co.

Contract W—Furnishing wooden stave pipe, 4,200 feet, and special castings. Tenders: Canadian Pipe Co., Vancouver, $2,309.50; Pacific Coast Pipe Co., Vancouver, $2,187.00. Awarded to Pacific Coast Pipe Co.

Kerrisdale, Point Grey, B.C.—The contract for the laying of sewers to serve the Kerrisdale and Magee districts in connection with the general sewerage scheme has been awarded to George H. Webster, and is estimated to cost in the neighborhood of $153,000. The outfall is down the Kaye Road into the Fraser River.

Penticton, B.C.—Messrs. G. A. Carlson and Company, railway contractors of Spokane, Wash., have secured the contract for 35 miles of road on the Kettle Valley line west of Penticton. Their contract will begin above Trout Creek and run to Osprey Lake, half-way to Princeton.

St. Catharines, Ont.—The Lincoln Construction Company have been awarded the contract for the laying of a duplicate water main under the Welland Canal at a cost of $1,495. The work includes piling and bank protection and according to the wording of the contract must be completed by May 22nd next.

Vancouver, B.C.—Messrs. H. L. Stevens and Company, of this city, have the contract for the erection of the new Molsons Bank of Canada, the building to be of brick and concrete block, 25 by 122 feet. Estimated cost, $80,500.

Victoria, B.C.—The Sydney Brick & Tile Company have secured the contract for the supply of 1,300,000 brick for sewer construction. Their prices were the lowest. Other bidders were Baker Brick & Tile Company, and Victoria Brick & Tile Company, each of which put in tenders of $15 per thousand, and that of Messrs Evans, Coleman & Evans at figures ranging from $14 to $17 per thousand.

Victoria, B.C.—The Seagrave Company, of Brantford, have received the contract calling for the supply of motor apparatus for the Fire Department. This order includes one combination hose and chemical apparatus, one double sixty gallon gas chemical wagon and one chassis for each of the fire engines and city service trucks now at fire headquarters. The total cost for this work is $29,075.

Westmount, Que.—The contracts for sewers on Western Avenue, Mountain Avenue and the Boulevard have been awarded to Messrs. R. G. Smith & Co. Estimated cost, $25,596.

Windsor, Ont.—Waterworks extension: Contractor, Messrs. W. J. Dupuis & Co., Detroit, Mich., and John Inglis and Company, Toronto; cost, $32,400.

Winnipeg, Man.—Preliminary contracts have been let for the construction of the big dry dock and shipbuilding plant at Prince Rupert. Contracts for the building of the piers, landing stage, building platform and launching ways have been given to the British-American Construction Company and representatives of that firm are now at the G.T.P. terminus making arrangements for commencing the work.

RAILWAYS—STEAM AND ELECTRIC.

County of Lanark, Ont.—Messrs. Larkin & Sangster, St. Catharines, are making preparations to begin work on the nine hundred foot tunnel on the new C.P.R. line near Glantay, in this county. The tunnel, which begins beyond Christy Lake, will take a year to construct, gangs working night and day on shifts of ten hours each. The contractors are putting in an air compressor plant that will work ten drills at one time.

Halifax, N.S.—The receipts for the week ending April 30th, 1912, of the Halifax Electric Tramway Company amounted to $5,211.43, an increase of $177.32 over the same period in 1911.

Montreal, P.Q.—Grand Trunk Railway traffic earnings for the period ending April 30th totalled $1,318,817, as compared with $1,125,144 for the last similar period, an increase of $193,673.

Montreal East, P.Q.—The municipality of Montreal East has established a line of autobuses to operate between this municipality and Place d'Armes, in Montreal, a distance of about eight miles. The first machine in operation, which started last week, is of the Berliot type, of twenty-four horsepower, and capable of seating comfortably twenty-eight passengers. The tariff has not been definitely fixed yet, but the rate will probably be ten cents.

Montreal, P.Q.—The new city by-law governing the operation of autobus lines within the city limits has been drafted and will be introduced in council within the next few days. One of the features of the new by-law is that any company operating a motor service must provide a seat for each passenger carried. The capacity of each autobus will be established by officials of the city and this limit must not be exceeded by the company operating the line.

Northern Canada.—A report states that the Government steamer Minto will convey an expedition to the Hudson Bay for the purpose of reporting on the respective merits of Port Nelson and Fort Churchill as the terminus of the Hudson Bay Railway.

Northern Ontario.—A report from Northern Ontario states that twelve miles of the right-of-way of the T. & N. O. Railway has been cleared, and over three hundred men are at work on the construction. Ballasting has commenced on the uncompleted portion of the Porcupine branch, and the depot at Timmins is now being erected. Chairman Englehart is hopeful that work on the new line will be sufficiently advanced to open for traffic by December 1. The outlook for the season's business is bright. A number of settlers are going into the country at points from Liskeard to Cochrane.

Province of British Columbia.—During a sitting of the Dominion Railway Board an edict was issued that provides that all locomotives operating in this province after December, 1914, must consume oil for steam generation. This followed an active movement on the part of the provincial authorities to prevent forest and grass fires during the dry season.

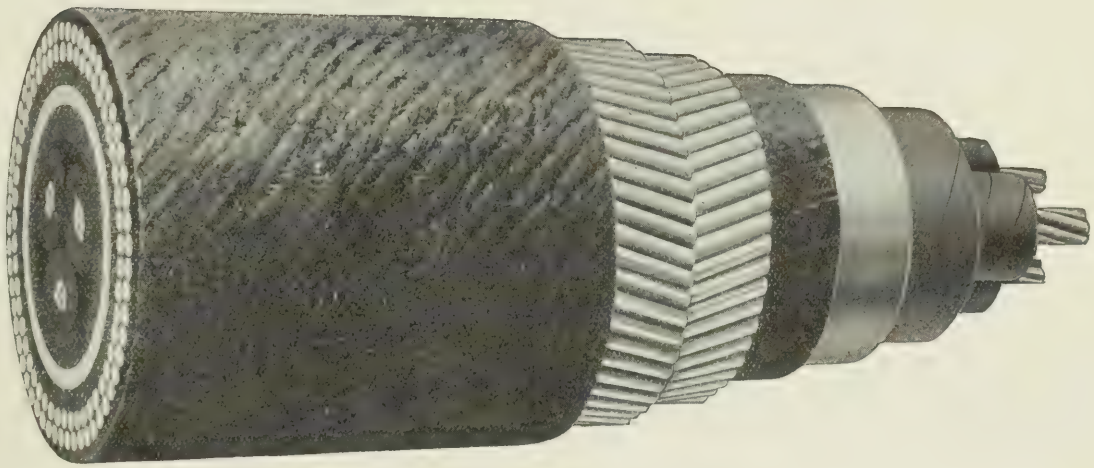
Quebec, P.Q.—It is reported that the Transcontinental Railway, after leaving the Quebec bridge, will descend by the river side for some distance, and will then enter the height of land somewhere about Wolfe's Cove. The location of the exit is not yet settled apparently, but the indications are that it will come out of the hill on a curve about half a mile outside of the city. The estimated cost of the tunnel is from $800,000 to $1,000,000, but if, as is expected, the excavation is seamy and it is necessary to line the tunnel, it may be much more.

St. Thomas, Ont.—Representatives of St. Thomas, Aylmer, Yarmouth and Malahide have practically agreed to guarantee the bonds of the London & Lake Erie Railroad for an extension of the line from St. Thomas to Aylmer.

The Cable across the St. Lawrence River

FROM

Pt. Aux Tremble to King Edward Park.



The longest paper insulated Sub-marine Power Cable on the Continent (supplied and installed by The Canadian British Insulated Co., Ltd., for the King Edward Park Company,) No. 6 B. & S. Gauge, 3 conductor, paper insulated, lead covered double wire armoured and juted.

1½ miles long—13,200 volts

We are prepared to undertake contracts for the Supply and Installation complete of Power Cables under a Five Year guarantee.

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HEAD OFFICE - MONTREAL

Toronto, Ont.—The municipal engineer has recommended that the Board of Control purchase three busses for use between Rosedale and the business centre. The cost of these would be $10,000 each.

Western Canada.—A report that has enjoyed extensive circulation in the West states that large interests are engaged in the matter of electric railway amalgamation and that should the plans mature the principal cities in the Canadian Prairie West will be linked together by electric lines operating under hydro-electric power. It is reported that the management of the Alberta Interurban Railway and the Manitoba Rural Railways Companies are interested in the matter.

LIGHT, HEAT AND POWER.

Hazelton, B.C.—The municipal council are giving serious attention to the latent powers of the falls on the Skena River near this town. It is claimed that 25,000 horse-power could be generated without any serious engineering work being involved, and that should this be accomplished, a large manufacturing district would spring up in the vicinity of this municipality.

Montreal, P.Q.—A report prepared for the municipal Board of Control shows that the cost of civic lighting will cost about $250,000. The estimate is made up as follows: Street lighting, $217,345; special lighting, $1,752; lighting parks and squares in summer, $2,178; lighting municipal buildings, $17,130; relocating lamps, $2,000; salaries of staff, $7,000. Realizing how large the sum is the controllers have studied the subject of municipal electric power. In another year's time the corporation will have completed the enlargement of the aqueduct. As this waterway is to be about three times its present width and nearly three times its present depth the result is that the water supply of the city will be much more than necessary for many years to come. Knowing this the chief engineer has prepared statements showing that it will be possible, with this extra supply of water, to develop power to do most of the street lighting. Not only is it the intention of the city to practically take care of all its street lighting, but the public buildings owned by the corporation will be cared for as well.

Saskatoon, Sask.—The municipal electrical department has shown a surplus despite the fact that reductions of 25 per cent. in power rates and 22 per cent. in lighting rate were introduced in the method of current sales. After allowing for the interest on debentures to the extent of almost $6,000, a depreciation of over $3,000 and a sinking fund of $2,328, a net profit of $2,451 is shown in a statement for the first quarter of the year which has just been made public. Saskatoon is the only city in Western Canada where electrical meters are free to the consumer.

Victoria, B.C.—The municipal council are making arrangements for the installation of a large electric sign to carry the words "Welcome to Victoria, the Gateway of the Pacific." It is to be placed on an eminence and is to be of such size that it will be visable for many miles at sea; thus serving the double purpose of a beacon light and a municipal advertisement.

GARBAGE, SEWAGE AND WATER.

Brandon, Man.—The ratepayers recently voted in favor of authorizing the issue of debentures amounting to $100,000 to be used for waterworks improvement. R. E. Speakman, City Engineer.

District of Muskoka, Ont.—With a view of preventing the pollution of lakes and streams the Provincial Board of Health is issuing dodgers warning the residents of that district against putting any garbage, animal or vegetable matter in the lakes and streams. A fine of $100 is imposed for a violation of this law.

Moose Jaw, Sask.—The ratepayers voted in favor of spending the sum of $60,000 on a new high pressure system in connection with the municipal water works system.

Port Arthur and Fort William, Ont.—The municipal council are having the waterworks system inspected by Mr. T. Aird Murray, of Toronto. It is probable that extensive changes will be made in the near future in this branch of the civic administration.

Sarnia, Ont.—Recent experiments conducted by City Engineer McLean to obtain information regarding the quality of water resulting from soakage through 30 feet of sand into test wells, resulted favorably. He plans to install a turbo-generator of 500-k.w., at the present water works, and from this operate pumps attached to about twenty additional wells.

BUILDINGS AND INDUSTRIAL WORKS.

Brandon, Man.—The ratepayers recently voted in favor of spending the sum of $33,000 to erect a new fire hall. R. E. Speakman, City Engineer.

Calgary, Alta.—Plans for the expenditure of $975,000 on new schools and school sites, $800,000 of it for the erection of schools, and $175,000 for the purchase of new sites to be held for future contingencies, were drawn up at a special meeting of the Calgary school board recently. Subject to the approval of the ratepayers, debentures are to be issued for $75,000 for 40 years at 4½ per cent.

Calgary, Alta.—Mr. G. D. Venine is preparing to erect an office and store building of brick and fireproof materials to cost $20,000.

Edmonton, Alta.—Plans have been prepared for the erection of a new Anglican Church to cost about $100,000. The new building, as planned, will be 150 feet long by 75 feet wide. The ground floor, raised five feet above grade and approached by three flights of steps from a wide vestibule will comprise the nave and side aisles, seating about 900, chancel with choir accommodation of 65, two transepts and large sanctuary and sacristy. Messrs. Barnes and Gibbs are the designers.

Fredericton, N.B.—The University Senate have announced their intention of erecting a substantial new grand stand at the atheletic grounds. It is to be constructed as soon as possible.

Hamilton, Ont.—Mr. H. H. New is preparing plans for the erection of a new children's hospital to cost $32,000.

Lethbridge, Alta.—The Free Masons of this city have made arrangements for the erection of a new hall to cost about $40,000.

Montreal, P.Q.—Plans have been prepared for a city hall annex and have been approved by the municipal council. The new structure will have a fine appearance and will do away with much congestion at the City Hall. In it will be situated the Recorder's Court, police headquarters, and health department. The annex will be four stories in height with granite foundations and a superstructure of sandstone. Tenders will be called at once for the erection of the building.

Moose Jaw, Sask.—The Saskatchewan Bridge and Iron Company have awarded the contract for the erection of their new machine shed on Fairford Street west to the Western Building Company. The new shed will be of iron-clad and steel construction 50 by 150 feet. The cost will be about $125,000.

Montreal, P.Q.—Mr. J. W. Birchenough will erect a $60,000 building on the corner of Bleury Street and Alexander Street.

Nelson, B.C.—Mr. E. Ross Mackenzie is interested in a project to erect a new opera house of brick, four stories in height to cost about $65,000. There will be seating capacity for about 900 persons.

Ottawa, Ont.—The Federal Government are considering the erection of dry-docks at the following points in Canada: St. John, N.B.; Quebec, P.Q.; Montreal, P.Q.; Toronto, Ont.; Sydney, N.S., and Prince Rupert, B.C. The docks at Collingwood, Ont., and Halifax, N.S., are to be extended.

Pincher Creek, Alta.—Plans that have been prepared for the erection of a new town hall for this municipality show a handsome building of brick, two storeys in height, with a large central tower above the main doorway.

Princeton, B.C.—Mr. Peter Swanson is having plans prepared for a hotel to cost $50,000.

Quebec, P.Q.—A report states that the Federal Government are considering the matter of reconstructing a portion of the breakwater at this point. This work will cost, according to the estimate, about $500,000.

Regina, Sask.—Plans have been prepared by Mr. F. N. Darrach for a new church building to be erected for the congregation of Westminster Presbyterian Church. They show a building with an arch at the entrance which will be support-

THE TRIPLEX BLOCK

A Triplex Block hung from a temporary rigging and used for laying pipe.

What is the Life of a Triplex Block?

WE don't know. Triplex Blocks built by the Yale and Towne Co. at the very beginning—twenty-five years ago—are still in actual use. The Triplex Block of to-day possesses greater lasting powers. With its steel parts—its chain superior to any other—its non-wearing gear movement—and the guarantee of a rigorous test before shipment under a fifty per cent. overload. It will outlast the man who buys it, no matter how young he may be.

The Canadian Fairbanks-Morse Company

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Fairbanks Standard Scales — Fairbanks-Morse Gas Engines
Safes and Vaults

MONTREAL ST. JOHN OTTAWA TORONTO WINNIPEG
CALGARY SASKATOON VANCOUVER VICTORIA

ed by four pillars set about halfway up the flight of steps, the doors being set well in from the pillars. The gable over the arch is high, and has a large window. The Sunday school adjoins the church. The cost of the work will be about $70,000.

Saskatoon, Sask.—A new company taking the name of the Concrete and Supply Company, has been formed with Mr. C. D. Fisher as president. The new company will manufacture cement, brick, Roman stone, and other ornamental stone. The plant is to be erected on the corner of Avenue L and 17th Street.

Saskatoon, Sask.—A report states that a Winnipeg firm contemplates erecting a seven-story building to be used for apartments and stores.

Saskatoon, Sask.—Dr. J. H. C. Willoughby and Mr. A. J. E. Sumner are preparing to erect a four story departmental store which is to be occupied upon completion by F R. McMillan & Co.

Sydney, C.B., N.S.—The firm of Mackay and Maxwell are having plans prepared for the erection of a new automobile garage to cost about $10,000. A recharging tank with appliances for recharging the new prestolight and searchlight tanks will be installed. An air pump attachment for tire pumping will be introduced also.

St. John, N.B.—Negotiations are under way for the transfer of limestone properties and the erection of a cement plant. The municipal council have agreed to sell the property for $26,200, on condition that the purchasers erect the plant and a report states that the deal only awaits ratification by the council.

St. Catharines, Ont.—A report states that the management of the Warren Axe and Tool Company, of Warren, Pa., U.S.A., propose the erection of a plant in this city. The ratepayers will vote on the question of the usual subsidy on May 9th.

St. Catharines, Ont.—A report from this city states that the management of the Reo Motor Car Company are contemplating the erection of a new factory in the vicinity of Berryman Avenue. About 80,000 additional square feet of floor space are required by the company as soon as possible.

Toronto, Ont.—The Toronto and Niagara Power Company intend to build a structural steel plant at the northeast corner of Shaw and Dupont Streets. The plant will cost $40,000.

Toronto, Ont.—The National Iron Works will commence work on an addition to their concrete dock.

Vancouver, B.C.—A report states that the management of the Canadian Home Investment Company have recently purchased a site in this city and contemplate the erection of a ten-story building to cost $1,000,000.

Vancouver, B.C.—The Northwest Commercial Travellers' Association have made preliminary arrangements for the erection of an office building in this city. The cost is estimated at $160,000.

Victoria, B.C.—Plans are being prepared by Thomas Hooper, Royal Bank Building, for a Women's Home to cost $19,000.

Windsor, Ont.—The National Auto Body Company, has been organized with a capital of $150,000. The company will manufacture auto bodies of wood, steel and aluminum, and will also build, trim and paint both open and closed bodies. A site covering three acres has already been purchased in the factory district and tenders calling for the construction of a number one plant have been advertised.

BRIDGES, ROADS AND PAVEMENTS.

County of Haltan, Ont.—The members of the county council are about to spend the sum of $[illegible]00,000 on road improvements covering over one hundred miles.

North Vancouver, B.C.—The estimated cost of constructing a bridge across the Second Narrows has been increased from $120,000 to $150,000.

Township of Morris, Ont.—The councillors of this township have found it necessary to issue debentures for the sum of $23,000, in order to replace the bridges which were swept away by the recent flood.

South Porcupine, Ont.—A large trestle bridge (200 foot) was destroyed by fire recently. It was on the line of the T & N.O. Railway seven miles south of Dane.

Toronto, Ont.—The civic engineering department has recommended the construction of an asphalt pavement on Bloor Street to cost $51,813. This will be from Bathurst St. to Dufferin St. The Works Committee are considering the question of widening the pavement on Spadina Avenue from 52 feet to 91 feet, at a cost of $35,231. This is from Queen St. to Baldwin.

FIRES.

Stratford, Ont.—The factory of Messrs. Totton Co.'s Willow Cheese manufacturers, was damaged by fire.

Treherne, Man.—Damage to the extent of $70,000 was caused by fire to the business section of this town. Among the damaged buildings the name of J. Adair & Son's implement warehouse appears.

Victoria, B.C.—The plant of the Canadian Puget Sound Lumber Mills was recently badly damaged by fire. This plant is at Rock Bay on Victoria Harbor.

CURRENT NEWS.

Brantford, Ont.—The ratepayers will vote on a by-law calling for the expenditure of $13,000 for improvements to the dyke system.

Collingwood, Ont.—The Collingwood Shipbuilding Company will construct a large freight ship for the Chicago and St. Lawrence Navigation Company of Toronto. It is to be ready for the opening of navigation in 1913 and will be the largest freighter operating on the lakes having a cargo capacity of 12,0000 tons. The dimensions are: Length over all, 550 feet; width between perpendiculars, 58 feet; moulded depth, 31 feet. The vessel will be built on the arch web system of framing, and will be fitted with side tanks and water bottom for her entire length. There will be 32 hatches with steel telescoping covers. The propelling machinery will be a vertical triple expansion engine, the cylinders being 24 in., 40 in., and 66 in. in diameter, with a 42-inch stroke. The steam will be supplied by three cylindrical boilers, each 13 feet in diameter, with a working pressure of 85 lbs., and they will be fitted with Howden's system of forced draught. The ship and machinery throughout will be built to the highest classification of the Great Lakes register. The vessel will cost complete about $375,000. Mr. W. D. Matthews is the president of the Chicago and St. Lawrence Navigation Company.

Hamilton, Ont.—The municipal council are seriously considering the question of purchasing auto trucks for hauling on civic works. The secretary of the Board of Control has been requested to secure prices and operation costs. Mr. A. F. MacCallum is the city engineer.

Nelson, B.C.—The management of the Nelson Gas & Coke Company have made overtures to the municipal council for the sale of their plant. They ask $75,000 for the business.

Ottawa, Ont.—The Civil Service Commissioners have announced that applications will be received for the position of architectural draughtsman in the chief architect's division, (Initial salary $1,300 per annum), and two draughtsmen in the same department with a salary of $800. Applications must be filed in the office of the Civil Service Commission, not later than the 20th day of May next.

Quebec, P.Q.—The Harbor Board of this municipality have arranged a plan of improvement which will cost about $1,000,000. A car ferry and a large grain elevator are on the list of improvements.

PERSONALS.

Mr. Arthur J. Demster, of Toronto, has been awarded the Science Research Scholarship by the senate of the University of Toronto.

Mr. Richard W. Allen, of the well-known firm of W. H. Allen, Sons & Co., Ltd., Bedford, England, was a visitor to Toronto this week.

Mr. L. K. Jones has been appointed to the position of Assistant Deputy-Minister of the Department of Railways and Canals for the Federal Government.

Volume 22. Toronto, May 16, 1912

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The Canadian Engineer

An Engineering Weekly

THE RED RIVER BRIDGE FOR THE NATIONAL TRANSCONTINENTAL RAILWAY

By D. C. TENNANT, B A., Sc *

PART 2.

The Strauss Bascule span of the National Transcontinental Bridge over the Red River is of the so-called Heel Trunnion type, the Main Trunnion being placed at the heel of the moving leaf. Plate No. 3 shows an elevation of the whole span and Plate No. 4 indicates in a general way the stresses and material of the more important parts.

Relative to the D.L. pier reactions in this type of bridge, it should be noted that since the moving leaf is at all times perfectly balanced, there is no D.L. reaction at the front end, and the weight of the entire structure is, therefore, carried by the two tower piers. Disregarding for the sake of simplicity the weight of the counterweight link and the operating strut, the reactions are due to:

1. The weight of the tower.
2. The weight of the moving leaf.
3. The weight of the counterweight including trusses and bracing.

Fig. 6.—General View of Bascule.

(1) The reactions due to the weight of the tower are vertical and constant.

(2 and 3) The moving leaf and the counterweight are supported on the tower as on a carriage; they do not rest directly on the pier, and if the tower is properly designed, it takes care of all the horizontal forces, the horizontal component of the main trunnion reaction neutralizing the horizontal component of the counterweight trunnion reaction through the tower.

It follows that the pier reactions due to the weight of the moving leaf and the counterweight are vertical. Furthermore, they are constant during the opening and closing of the bridge. Owing to the fact that the four pins, main trunnion, counterweight trunnion and first and second link pins are located in the corners of a parrallelogram, the angular movements of the moving leaf and the counterweight are the same, and as the weight of the moving leaf is as much smaller than that of the counterweight as the lever arm of the latter is smaller than that of the former, it follows that the centre of gravity of the system as a whole is not disturbed during the operation of the bridge, and, therefore, the pier reactions cannot vary. This proved, it can be seen that the D.L. reaction on the main trunnion pier (disregarding the reaction due to the weight of the tower) is equal to the weight of the moving leaf and the D.L. reaction on the counterweight trunnion pier equal to the weight of the counterweight. If, namely, the bridge is open to such an angle (about 90 degrees) that the centre of gravity of the moving leaf falls directly over the main trunnion, then at the same time the centre of gravity of the counterweight falls directly below the counterweight trunnion; the trunnion reactions have no horizontal components and it becomes evident that of the two piers the one carires the moving leaf and the other the counterweight.

In considering the reaction on the main trunnion, we note that the moving leaf is subject to three outside forces only, viz.:—

*Chief draughtsman with the Dominion Bridge Company, Montreal. Mr. Tennant is an honor graduate of the Faculty of Applied Science and Engineering University of Toronto.

NOTE.—The first part of this article was published in *The Canadian Engineer* of April 18th.

1. The weight of the moving leaf, which is a vertical force passing through the centre of gravity of the moving leaf.

2. The link stress (link pin reaction) which passes through the second link pin and which coincides in direction with the counterweight link. Since this pin is connected at both ends and would not be in equilibrium under any other condition.

3. The main trunnion reaction.

Since the bridge is balanced this third force must pass through the point of intersection of the two others. When the bridge is closed this point of intersection falls near the centre of the span and somewhat below the bottom chord and the D.L. main trunnion reaction is, therefore a force which passes through the trunnion and is directed towards the point of intersection, while the moving leaf butts against the trunnion in a direction that is inclined slightly upwards and towards the tower. It follows that according to the design the base (or body) of the main trunnion bearing, which is rivetted to the heel of the bascule truss, will always bear against the trunnion, which is keyed to the tower truss, and that the cap on this bearing might, therefore, be omitted if it were not for practical reasons (lubrication, etc.). This also is shown by analyzing the stress in the truss members. The D.L. stresses in the four members intersecting at the hip point (2nd link pin), including the end post, are all tension. Of the two members intersecting at the main trunnion, the D.L. stress in the end post is tension, as stated, while the D.L. stress in the bottom chord member is compression and the resultant of these two forces is a force inclined slightly upward and acting away from the moving leaf against the tower, which again produces a reaction from the tower, as described above.

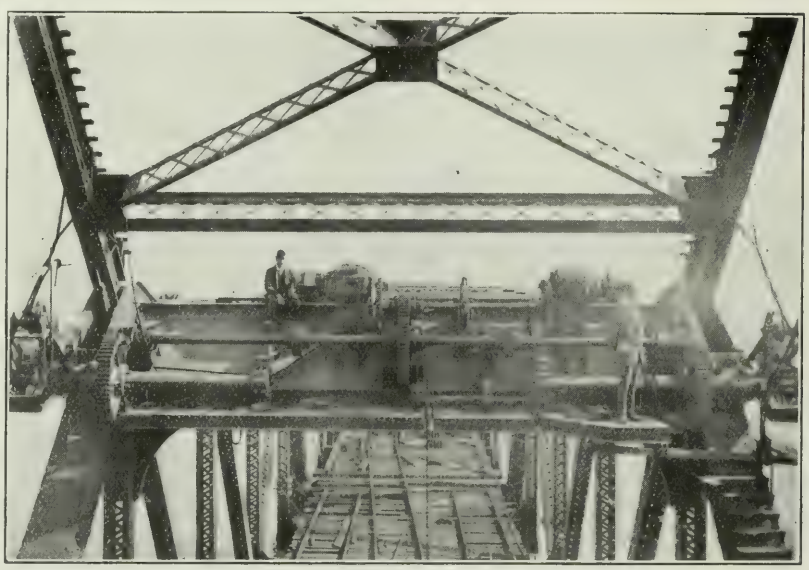

Fig. 2.—Portal and Machinery of Moving Leaf, as Seen from Counterweight Tower.

The L.L. reaction on the trunnions and the L.L. stresses in the truss members are in no way different from those in an ordinary truss. The thrust of a train (breaking load) coming from the trunnion end of the bridge, however, will tend to push the moving leaf away from the trunnion (that is, produce bearing on the cap of the trunnion box and tension in the cap bolts), but in all cases so far investigated, this force has not been sufficient to overcome the D.L. going in the opposite direction, and it could in any event be properly cared for by making the cap sufficiently strong.

In designing the bascule span, the regular Dominion Government stress of 16,000 pounds per square inch for tension was used, but compression stresses were not allowed to exceed 13,000 pounds per square inch, and stresses, either tension or compression with the bridge moving were kept down to 13,000 pounds per square inch.

The moving leaf spans a clear waterway of about 110 feet, and in general outline it resembles the four 150-ft. fixed spans between the east abutment and pier No. 4. The trusses are 32 ft. 8 in. deep centre to centre of chords and are made up of five panels, the one next the main trunnion being 30 ft. 10 in. and the other four 24 ft. 8 in. each, making a length centre to centre of 129 ft. 6 in. The cuts in the floor of the bridge are made at the front end of the bascule and at a point a few feet east of the main trunnion, so that the floor of the moving leaf will in both cases lift from the fixed floor when the bridge is opened. The end floor beam at the trunnion end is set 6 ft. 2 in. east of the trunnion, making a span for the stringers in the end panel of 24 ft. 8 in., or the same as in the other four panels of the moving leaf. The front end of the moving leaf is received when the bridge is closed on two cast steel pedestals securely anchored to pier No. 4. These pedestals have tapered cast steel guides fastened on top of them so that the span descending to its horizontal position is brought into perfect alignment with the rest of the bridge. There is no dead load reaction at this end of the moving leaf so the span is latched to the pedestal to keep it in position. There is a latch on each side attached to the ends of the trusses and operated by an electric motor fastened to the bottom chord. The latches can also be worked by hand.

The moving leaf and the counterweight are supported on a triangular tower spanning between piers No. 5 and No. 6, a distance of 40 feet, which is the horizontal distance between the main trunnion and the counterweight trunnion. The vertical position of the concrete counterweight is governed by the height of 22 ft. 6 in. clear beneath it, necessary for trains when the bridge is closed. The horizontal distance from the counterweight trunnion to the centre of gravity of the counterweight, is governed by the necessity of its swinging clear of the top of the rails when the bridge is open. As the two link pins and the two trunnions form the four corners of a parallelogram the angular motion of the counterweight will be equal to the angular motion of the moving leaf, or 80 deg. 30 min. when the bridge is fully open. The line joining the main trunnion with the centre of gravity of the moving leaf will point slightly upward, therefore the line joining the counterweight trunnion with the centre of gravity of the counterweight must point slightly downward and the weight of the counterweight is greater than that of the moving leaf in proportion as its leverage is less.

As will be seen by referring to Plate No. 3, the trusses of the moving leaf and of the counterweight frame itself are set with their centres 31 ft. 3 in. apart centre to centre transversely. These bear against the main trunnion and counterweight trunnion pins which are at right angles to the centre line of the tracks and span, a distance of 5 ft. 0 in. transversely, their outer ends being supported on the trusses of the main tower, which consequently are spaced 36 ft. 3 in. apart centre to centre. The inner ends of the main trunnions are supported on auxiliary shoes 26 ft. 3 in. apart resting on pier No. 4, and the horizontal component

of the thrust on these shoes is resisted by a girder with horizontal web 9 ft. deep extending from the back of the shoes to the first panel point in the counterweight tower. The inner ends of the counterweight trunnions are supported on auxiliary posts 26 ft. 3 in. centre to centre, carried on a cross truss 7 ft. 9 in. deep centre to centre of chords spanning between the main vertical posts of the counterweight tower. The horizontal component of the thrust on these auxiliary posts is resisted by an inclined truss spanning between the inclined top chords of the tower. The tower is divided into three panels, two of 12 ft. 6 in. and one of 15 ft. 0 in, the long one being next the counterweight trunnion. The vertical distance centre to centre of trunnions and consequently the height of the tower centre to centre is 40 ft. 3½ in. The stringers and floor beams of the floor are similar to those of the moving leaf, but the floor beams are longer owing to the greater width centre to centre of trusses. On account of the great width and short span, together with the presence of the horizontal stiffening girder, no bottom laterals were deemed necessary. The main verticals are stayed against vibration and wind action by a system of wing bracing anchored to the concrete pier 7 ft. 2 in. from the C.L. of the trusses with four 3½-in. anchors running 15 ft. into the masonry. The base of this wing brace rests on a grillage of five 24-in. I's at 100 lbs., 13 ft. long, continuous under the brace and the main post, and this grillage, the anchors for the wing brace and also four 1¾-in. anchors 6 feet long for the main post were set while the masonry was being built, the grillage being embedded in the concrete, flush on top. The main trunnion shoes of the tower trusses and the auxiliary shoes rest on longitudinal shallow girders 15 inches deep, built up of plates and angles with stiffeners, these in turn resting on two grillages, one under each trunnion composed of six 18-in. I's at 65 lbs., 10 feet long, running transversely. Each shoe is anchored with four 1¾-in. bolts running 11 ft. 0 in. into the masonry and the built girders, grillages and anchors were all set in place while the concrete was being built, the tops of the girders being flush with the top of the pier.

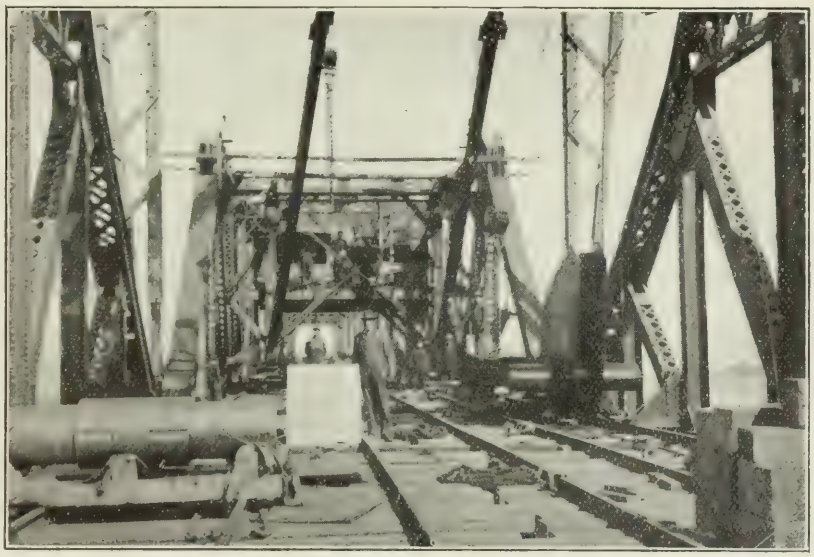

Fig. 3.—Looking from Counterweight Tower Towards Moving Leaf. Showing Erection Traveller About to Raise Counterweight Trunnions to Place.

The counterweight frame is of the dimensions and material noted on Plate No. 4. The joints at the counterweight trunnion and the first link pin were well reinforced with plates to take the bearing of the pins and the main gusset plates were extended beyond the sides of the main members, the outer edges being reinforced by stiffener angles curved to conform to the outline of the plate. (See Plate No. 3.) This was also done on the main trunnion shoes and on the moving leaf at the second link pin. The weight and position of the concrete in the counterweight was finally carefully calculated from the shipping weights of the various members composing the counterweight frame and the moving leaf. The concrete is composed of one part cement, three parts sand, and five parts gravel, and was found by trial to weigh 141 lbs. per cubic foot when dry. Four large pockets were left which, after the concrete was dry, could be either totally or partially filled with concrete adjusting blocks weighing from 350 to 700 pounds each. As finally calculated, the total weight of concrete necessary was 1,756,000 pounds, so the dimensions were arranged to provide for 1,656,000 pounds and the pockets, if filled, would give 200,000 pounds extra. Thus the bridge would balance with the pockets about half full. Tests on the bridge since completion prove the assumptions to have been substantially correct.

The main trunnions are turned pins 16½ inches dia. They are supported on built shoes and are keyed to cast steel collars which are fastened to the shoes with turned bolts. The thrust from the moving leaf is applied through a cast steel box, bolted between the gusset plates of the moving leaf which in turn are stiffened up with radial diaphragms. The steel box has a cap fastened on with six 2¾-in. studs, and is fitted with a phosphor bronze bushing to take the wear. Lubrication takes place through the counterbore of the trunnion, which is connected with the surface of the pin by these canals, and there are no grease cups in the cap.

The counterweight trunnion is a 22-inch turned pin, keyed to the counterweight frame. It is reduced to 18½ inches at the ends where it runs in cast steel boxes resting on the top of the tower. These boxes also have cast steel caps and compression grease cups in the caps.

The stress in the counterweight link will vary from zero when the centres of gravity of the moving leaf and the counterweight are respectively directly above and directly below the trunnions to a maximum when the bridge is closed. The link pins, both first and second, are 8 inches dia. Inside the gusset plates of the trusses the pins are surrounded by cast steel collars 19 inches dia., bolted to the gussets. The link bears on these collars. The ends of the link are fitted with cast steel bearing collars and bronze bushings lubricated from compression grease cups.

The bridge is operated by an operating strut pin connected to the top chord of the tower at one of the intermediate panel points. This strut has bolted to its under side a cast rack which engages a pinion on the moving leaf near the hip joint, the pinion being held in mesh with the rack, by means of a carriage with rollers bearing against the top and bottom flanges of the operating strut. This pinion is driven by means of two 40 h.p. electric motors and a series of gears that are very clearly shown on Photo No. 4. The portal at this end of the moving leaf consists of two girders, one with a vertical web and one with web inclined at the same slope as the post, as shown on Plate 4. From the bottom of these two girders a platform is cantilevered out towards the counterweight tower and the

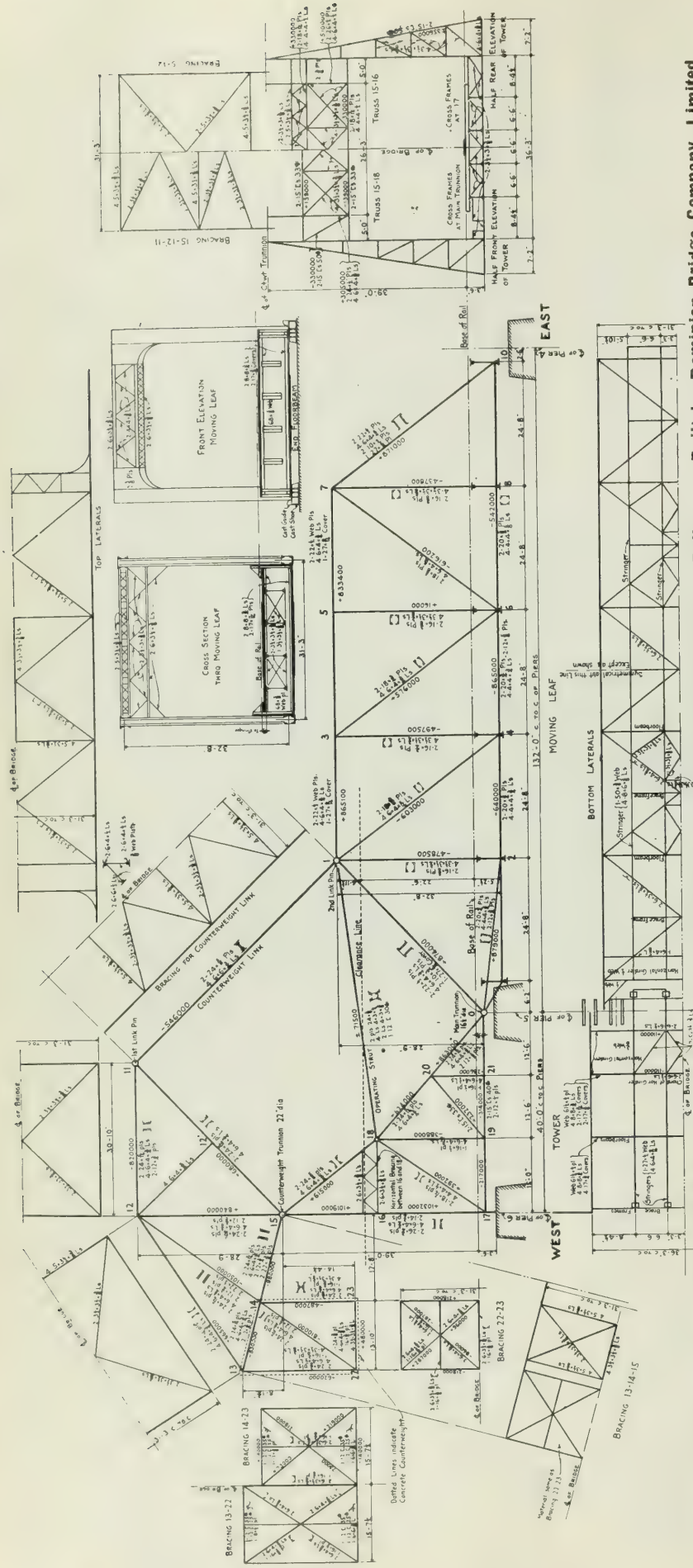

Plate A.—The Strauss Trunnion Bascule Span of the Red River Bridge for the National Transcontinental Railway., Built by Dominion Bridge Company, Limited.

machinery is carried on this platform and the portal. The lubrication of this machinery was arranged so as to be effective at any position of the bridge. The bridge can also be operated by hand from the lower deck by a chain.

The operator's cabin is situated on the south side of the bridge and rests on brackets that cantilever from the outside of the tower truss almost directly over the main trunnion. It is indicated on Plate No. 3, but has two stories instead of only one, as shown on the plate. The upper story was added to accommodate the storage batteries to operate the electric interlocking signals controlling the approaches to the bridge. It contains the switchboards from which are operated the main driving motors of the bridge, the motor for the latches on the toe of the moving leaf, the brakes, etc. An automatic cut out is arranged to prevent the bridge from opening a greater angle than 80 degrees 30 minutes or the fully open position. Automatic signals indicate for the railway and for navigation, when the bridge is open and when shut.

Since the first four heel trunnion bascules were designed, namely, the Red River bridge, the Cape Cod Canal bascule for the New York, New Haven and Hartford Railway, the Illinois River bridge for the Peoria and Pekin Union Railway, and the Ashtabula Harbor bascule for the Lake Shore and Michigan Southern Railway, a change has been made by the Strauss Co. in the design, putting the tower trusses in line with those of the moving leaf and counterweight frame, thus obviating the necessity of long trunnion pins spanning between two shoes and simplifying the details generally. It might be stated here that the Baltimore and Ohio bridge over the Calumet River, which is a 235-foot double track bascule, and the Canadian Pacific bridge over the Sault Ste. Marie Canal, which is a 336-foot single track span, are respectively the longest double track and single track bascules in the world.

Erection was begun from the east end of the four 150-ft. truss spans and continued westward till the bascule, the viaduct, and the spans over Notre Dame Street and Water Street, were completed, the spans at the east over the Canadian Northern and Tachè Avenue being put in last. The erection scheme will be better understood by referring to Plate No. 1 in the issue of *The Canadian Engineer* of April 18. The material was delivered by rail on the Canadian Northern tracks close to the east shore of the Red River. From the cars it was raised to the level of the Transcontinental tracks as required. The fixed truss spans and the bascule were erected on wooden falsework resting on the river bottom. The special erection traveller that was used is shown in Photo No. 5.

It also appears in Photos No. 2 and No. 3 of the issue of April 18. It was desirable to use the same traveller for the truss spans and the viaduct. It therefore had to be made low enough to go under the sway bracing of the truss spans. As the bridge was double track, the traveller was made as wide as the through trusses would permit, and carried a mast and boom on each side capable of being operated independently. Since the viaduct has quite an appreciable curve the wheels of the traveller were specially arranged to take the curve easily. This was accomplished by placing an ordinary car truck of four wheels at each corner of the traveller. The centres of the four trucks formed a base of 27 ft. 6 in. longitudinally by 18 ft. 0 in. transversely, the traveller running on two tracks of standard gauge with a width of 18 ft. 0 in. centre to centre of tracks. The frame of the traveller was made entirely of wood. The two trucks on each side are 27 ft. 6 in. apart, supported longitudinal wooden trusses 6 ft. 0 in. deep. These each had a vertical mast in front 18 ft. 6 in. high of 12 x 12 timber, the top of each mast being stayed to the bottom chord of the wooden truss at a point over the back truck, by two 1⅜-in. square steel tie rods. The booms were of 12 x 12 timber 35 ft. 0 in. long, and were capable of lifting 10 tons each. Across the tops of the wooden trusses were laid 6 x 12 cross ties 19 feet long, and to these was spiked the floor of the traveller. The engines rested on this platform, being placed over the back trucks in an enclosed cabin. Thus, under the centre of the traveller there was a clear head room of about eight feet under the cross ties or the height of the trucks plus the height of the truss. There was also a clear width underneath of about 12 feet between the trucks. In this space a third track of standard gauge was run along the centre of the bridge and on this track the material was brought on hand trucks from the delivery tracks at the east end of the bridge forward to the front side of the traveller within range of the derricks. This traveller erected all the truss spans and approach girders, except the more elevated members of the tower and counterweight which were put up with a gallows frame. The forms for the concrete of the counterweight were supported on heavy woodwork resting on the most easterly girder span of the long viaduct.

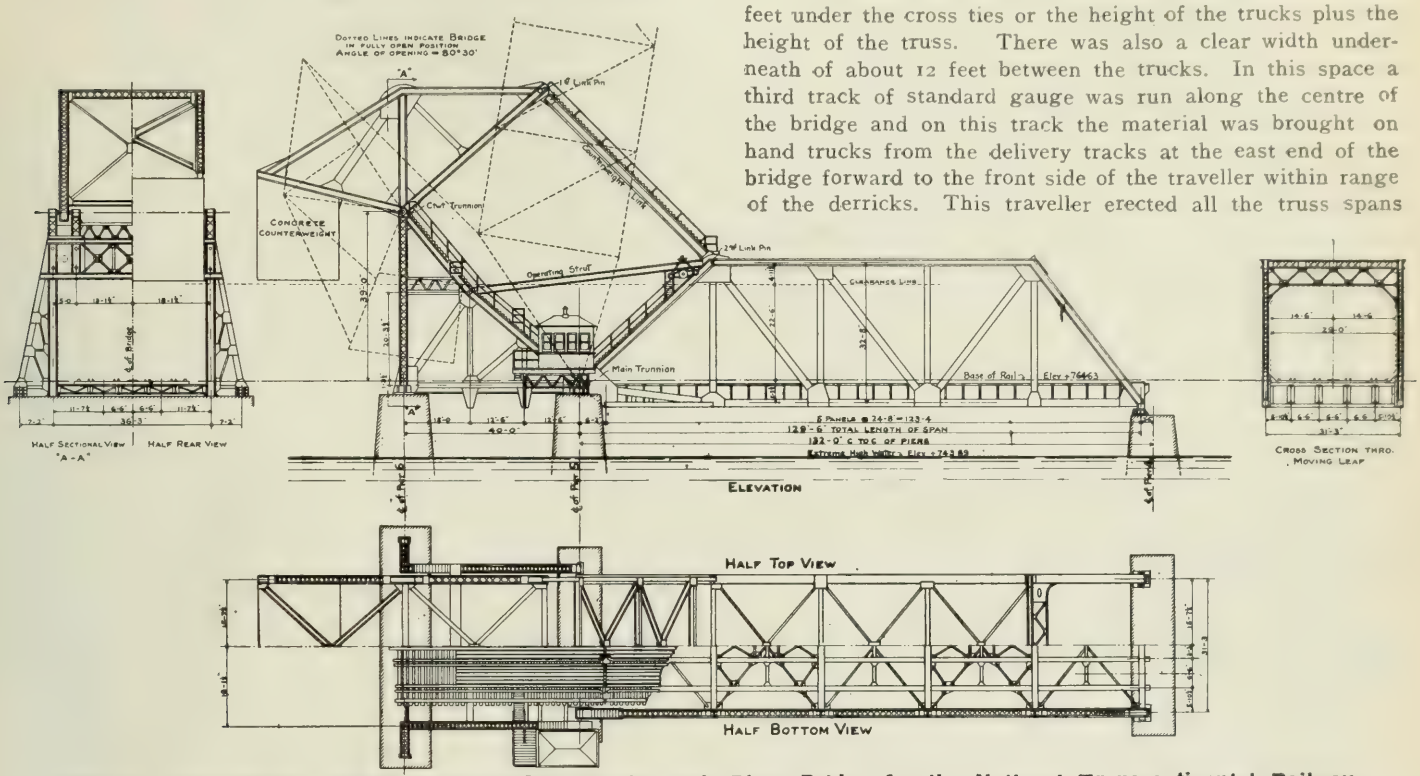

Plate 3.—The Strauss Trunnion Bascule Span of the Red River Bridge for the National Transcontinental Railway. Built by Dominion Bridge Company, Limited.

In conclusion the writer wishes to most heartily thank Mr. Uniacke, the bridge engineer of the Transcontinental Railway, and Mr. Jeppesen, the designing engineer of the Strauss Bascule Bridge Co., for photographs and other information in connection with the bridge; without the co-operation of these gentlemen and also of the Dominion Bridge Co., this paper would not have been possible.

FAREWELL BANQUET IN HONOR OF CITY ENGINEER RUST AT ENGINEERS' CLUB, TORONTO.

Last Friday evening about ninety members of the Engineers' Club of Toronto, representing all phases of the engineering profession, sat down to a complimentary dinner in honor of Mr. C. H. Rust, City Engineer of Toronto, who left this week to assume his new duties as City Engineer of Victoria, B.C.

Mr. Willis Chipman occupied the chair, on the right of whom sat the guest of the evening, Mr. C. H. Rust, and on his left Mayor Geary. Other representatives of the city's life who were present and joined in this testimony to Mr. Rust's worth, character and ability were R. T. Coady, city treasurer; F. S. Spence, vice-chairman of the Harbor Commission; H. L. Drayton, corporation counsel; Alex. C. Lewis, secretary of Toronto Harbor Commission.

Mr. J. G. Sing, resident engineer for Department of Public Works, proposed the toast to the guest of the evening. Mr. Sing referred to the loss not only the engineering profession would suffer by Mr. Rust's removal to the coast, but also the loss to the public life generally. He also spoke of the high character of Mr. Rust's work in Toronto during the past years.

Responding to the toast, Mr. F. S. Spence supplemented Mr. Sing's remarks and paid special tribute to the integrity and uprightness that Mr. Rust had always displayed in his municipal life. Following this Mayor Geary made a few remarks along the same lines to which Mr. Rust responded, and with some feeling referred to the breaking of connections with a city with which he had been so long identified.

At the conclusion of the proceedings Mr. Rust was presented with a bound souvenir menu containing the autographs of all the guests.

SELECTION OF A WATER-WHEEL UNIT.*

By O. B. Coldwell.

(Continued from last week.)

It is interesting to note, from Fig. 7, that where K = 20 with loads varying from 70 to 100 per cent. of full load, the per cent. of full load efficiency varies from 100 to 103 per cent. If therefore, the full load efficiency of this particular runner is 82 per cent., the actual efficiency between 70 per cent. and full load would be somewhere between 82 per cent. and 0.82 × 103 or 84½ per cent.

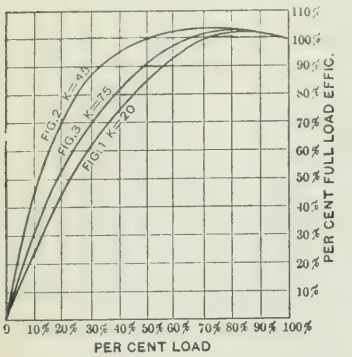

Fig. 7.
Comparative Efficiency Chart.

Let us consider Fig. 8. Here we have plotted the maximum actual efficiency against specific speed. It has been found by experiments which have been made by a number of manufacturing companies

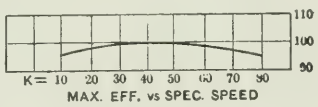

Fig. 8.

from time to time that the specific speed resulting in the highest efficiency is somewhere between K = 40 and K = 50.

A consideration of the factors entering into the design of water wheel runners, and of tests which have been made on various designs, shows that it is not possible to secure as high efficiencies, even though the operating conditions be the most favorable, for specific speeds which are higher or lower than the specific speeds between K = 40 and K = 50. Experiments have also shown that there is a certain best speed for each particular type of runner, which speed gives 100 per cent. power. At all other speeds, either higher or lower, the power is not so great. The variation of power for changes in speed, however, is different in magnitude for different types.

Fig. 9 shows this for two different runners, one where K = 45, the other where K = 75. In this diagram the best speed is shown at the centre ordinate as occuring at 100 per cent. full power, and it will be noted that as the speed is made higher or lower than this best speed, the power drops off for both types of runner. In the case of the runner K = 75, it drops off considerably more than for the type K = 45. For instance, an examination of the charts show that an increase in speed of a Type 2 runner, with K = 45, of 10 per cent. above the best speed, decreases the horse power 4 per cent. while a decrease of 10 per cent. from the best speed decreases the power about 2 per cent. For a runner with K = 75, the horse power is decreased 6 and 4 per cent. respectively.

In Fig. 10 is given a curve showing the relation between variation in head and equivalent variation in speed. This is really a graphical expression of the formula rev. per min. oc $\sqrt{H}$ or the equivalent expression rev. per min. = (a constant) $\sqrt{H}$. It will be noted by examining this chart that for a variation in head of 20 per cent. there is an equivalent speed variation of 10 per cent. For a variation in head of 40 per cent. there is an equivalent speed variation of nearly 20 per cent. This curve will be of use later on in our discussion.

With information such as the foregoing at hand, we should be able to select the best speeds, power, ratings, etc., for use in any given installation.

Number of Units in the Plant.—In order that a plant may work to best advantage on the load it has to carry, it must be designed to accommodate the characteristics of that load. In making this determination, a careful study should be made of the load curve and the load factor. There are also a number of other matters of importance entering into this particular subject; for instance, the question of whether or not the plant being designed is to operate alone or in parallel with other plants, whether there is to be a spare unit provided, etc. It is not intended to enter into any lengthy discussion of this subject at this time. Unless the purchaser has reliable information for arriving at a decision on the number of units to be used in the plant, it it advisable for him to secure the assistance of an engineer familiar with such subjects.

Size of Generators.—The generator should have a rated output approximately the same as the most economical capacity of the water wheel. It is assumed that an effort will be made to operate the generator as near as possible to its rating. It must be remembered that the most economical point of the wheel varies for different specific speeds. Even though the rev. per min. may not be determined and the specific speed not yet calculated, it can be at once found out from the curve that the maximum horse power of the wheel divided by the kw. rating of the generator should vary from 1.5 to 1.9. This is obtained by dividing the maximum horse power by the horse power at the most economical point and then again by 0.746 to reduce kw. rating. It may thus be said that the maximum horse power of the wheel divided by the kw. rating of the generator will vary from 1.5 to 1.9, depending upon the type of runner to be used. Manufacturers could, therefore, make up a tabulation of the value of this coefficient for their different types of runners. In the first approximation the value of this coefficient might be taken as 1.75, about the average value, and the kw. rating of the generator determined. Later on this could be corrected. The matter of overload should be kept in mind when this point is being worked out.

Standard Speed of Generators.—The electric manufacturing companies can supply tables of speeds for standard generators. Generators with frequencies of 25 and 60 cycles are the most common in use. It is not necessary to give such a table in this paper as it would be altogether too large if it covered all of the standards in use by the electric manufacturing companies. In such a table furnished the writer recently there are to be found for some of the more common sizes of generators met with in modern plants as many as 5 or 6 speeds standardized for each size. For instance, one company has made and is prepared to make a 175-kw. generator of water wheel type for 150, 180, 300, 514, and 600 rev. per min, and for full load voltages of 600 2,300 and 11,000-volts. Several speeds would be considered by the designer before making a choice, and the reasons governing the choice will now be considered.

What Speed of Unit is Based Upon.—The following elements enter into the selection of the speed of the unit: (a) head, (b) characteristic efficiency, (c) runner balancing, (d) speed regulation, (e) variation in head, (f) durability of design. We will discuss these points in order.

(a) Head.—The head is a most important factor in the selection of the speed. Low heads and attendant low

* A paper presented at the Pacific Coast Meeting of the American Institute of Electrical Engineers, Portland, Ore., April 16-20, 1912.

velocities permit of a design of bucket to handle large quantities of water. In such a runner, thin warped buckets of ample size and large openings can be used. These buckets are, relatively speaking, structurally weak. High heads and consequent high velocities make necessary a simple design of bucket, thicker material, and, therefore, relatively small quantities of water. Strength, therefore, must be carefully considered in determining the diameter and speed of a runner. In general it may be said that for proper strength and design, the following specific speeds may be used for any head below the maximum head given.

Specific Speed. K rev. per min.	Maximum Head. feet.	meters.
68 to 75	50	15
50 to 68	100	30
35 to 50	200	61
25 to 35	400	122
10 to 25	600	183

This tabulation is not by any means fixed and is merely given as a guide. If the specific speed figures out for any given head as greater than the values given above, two runners should be used. If two runners are used, the specific speed must again be figured out with a horse power one-half of that used before. If head were the only determining factor, the specific speed could be chosen from the above table and the rev. per min. calculated from the formula.

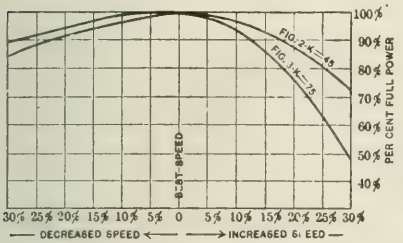

Fig. 9.—Effect on Power of Change of Speed, Based on Constant Head.

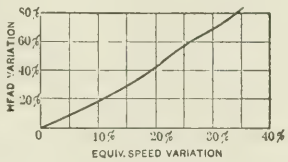

Fig. 10.
(See Fig. 9.)

(b) Characteristic Efficiency.—It has already been shown that different values of K result in a different efficiency characteristic. From our formula it is noted that specific speed varies with rev. per min., hence for any given horse power and head the rev. per min. fixes the specific speed, and the efficiency which is obtained from a runner with this specific speed both for full load and for partial loads. The particular speed characteristic desired, therefore, has much to do with selection of the speed of the runner.

(c) Balancing.—A single runner can be designed so as to balance thrust. This is sometimes desirable. With a single runner we have a lower specific speed and, therefore, consequent large diameter of runner. This should be considered by the designer and used where possible. The question of thrust does not enter into consideration with a pair of runners, as these are placed on a shaft as right and left-hand runners and the thrust of one runner is neutralized by that of the other. It is often found, however, that when a pair of runners is used, other conditions of the design must suffer and perhaps to the disadvantage of the installation. In making a proper selection of speed, therefore, the question of balancing is of importance.

(d) Speed Regulation.—Speed regulation is oftentimes the most important item in fixing the speed. The lower the speed the larger are the diameters and weights of the rotating element and, therefore, the greater flywheel effect of the unit. When the load on the unit is changed the speed varies directly with the flywheel effect. It is therefore often desirable to use a lower speed, fixing this speed by the degree of regulation desired. Extra flywheel effect can be obtained by the use of a flywheel, but this is generally undesirable and if possible should not be considered on account of the danger due to high pressures on bearings, etc.

(e) Variation in Head.—This is a common condition in low head plants. In hydroelectric plants the speed must be kept constant, even though the head does vary. In the case of pulp grinding mills, speed variation is not of so great importance.

We have already shown in Figs. 8 and 9 that different speeds have different characteristics of power and efficiency when the runners operate under heads other than the heads they were designed for, and lower speed than that given in some manufacturers' standard table of speed may oftentimes be used to advantage and might mean a considerable increase in the output of the plant. At the same time the initial cost may be greater and in such cases a proper balance between cost and benefits must be found.

To get a full conception of the effect of variable speed let us take an example:

Example.—A certain water plant has installed in it a water wheel runner of type No. 3, K = 75, which is designed to deliver 1,000 h.p. maximum at 200 rev. per min. when operating at 40-ft. (12 m.) head. This particular plant is so located, however, that the head varies due to floods, and at times the operating head drops down from 40 to 24 ft. (7 m.) The plant is a hydroelectric plant, and the generators driven by the water wheels require a constant speed of 200 rev. per min. in order to operate properly on the electric system connected to them. Let us investigate what will happen under these conditions. One of our fundamental formulas states that the horse power varies as $H^{3/2}$. Therefore, at 24-ft. (7-m.) head our 1,000-h.p. wheel will give $\frac{1{,}000}{\left(\frac{40}{24}\right)^{3/2}} = 465$ h.p. This calculation, however, is based on the assumption that we allow the wheel to run at the proper speed for 24-ft. (7-m.) head, which speed would be in accordance with the formula: rev. per min. oc $H^{1/2}$. Thus, $\frac{200}{\left(\frac{40}{24}\right)^{1/2}} = 155$ rev. per min.

Now, as a matter of fact, we do not want to allow this change in speed for the reason stated above, and as this is the case, we must sacrifice some of our power. If, therefore, we decrease the head from 40 to 24 ft. (12 m. to 7 m.) which is a drop in head of 16 ft. (5 m.) or a change of 40 per cent. in head, we will have, in accordance with the chart in Fig. 10, a corresponding speed variation of approximately 20 per cent

Referring now to Fig. 9 we note that for an increase of 20 per cent. in speed, there is a corresponding decrease in power for a Type 3 runner of 25 per cent. We would sacrifice, therefore, when operating at these changed conditions, 25 per cent. of the power which the runner operating at its best speed for this head possesses, that is, 25 per cent. of 465 h.p. or 115 h.p. We would have left, therefore, when operating the wheel under these changed conditions as brought about by flood, the difference between 465 h.p. and 115 h.p., or 350 h.p. If a runner of type No. 2 K= 45, should be installed in this plant instead of a runner of Type No. 3, it is readily seen from Fig. 9 that when operating under the changed conditions brought about by the flood, the loss in power, instead of being 25 per cent., would be but 12 per cent., which is a loss of 57.5 h.p. The power,

therefore, of a type No. 2 wheel, if installed in this plant, and operating under the altered conditions, would be 465 h.p. minus 57.5 h.p., or 407.5 h.p.

(f) Durability.—In high head installations particularly, pitting of the runner blades takes place, due to shock of water against the buckets, or high velocity, and the operation of the unit much of the time at other than the most economical point. This being the case, it is quite important to consider durability when making the selection of the proper speed of runners. Let us again consider the formula $v = 52\sqrt{H}\sqrt{\frac{\sin (A+B)}{\sin B \cos A}}$. If we select a value of B = 90 degrees the trigonometrical expression under the radical sign becomes unity, changing the formula into $v = 52\sqrt{H}$ which is the formula for discharge from a simple nozzle. It is found when a value of B = 90 degrees is selected that the pitting is reduced to a minimum. From the above deduction this would be expected.

In the foregoing discussion we have considered a large number of items which enter into the subject of water wheel design and have indicated the desirability of getting some good engineering advice when selecting a unit. We have not, by any means, covered all of the points which enter into this interesting subject, nor would it be possible to do so in the time at our disposal. It is not expected that in general the buyer should acquaint himself with all of the various formulas and curves which have been dwelt upon. It has been necessary, however, to review them in a brief manner in order to lead up to the recommendations to the purchaser selecting a water wheel unit.

Ceneral Design of Unit.—The conditions which must be met with in the particular plant where the installation is to be made determine the general make-up of the unit. Water wheels may have but a single runner, may have a pair of runners, or for low heads, four or even six runners to the unit. In some places a vertical design of unit is required, while in others horizontal units best suit the conditions in many instances; it is merely a matter of taste, but in most cases there are features which influence the selection of horizontal or vertical units.

When a pair of wheels is used, it must be determined whether an outward discharge or a bottom centre discharge is the more desirable. Both schemes are used, one involving a single draft tube, the other, two draft tubes.

When low heads are met with, open flumes are possible and a properly arranged open flume may take the place of the closed flume. In high head work it is, of course, necessary to use a closed flume.

The housing enclosing the runners may have various forms. For instance, it can be a scroll case design or a cylindrical design; it can be made out of cast iron, cast steel or steel plate or may even be formed in concrete. The scroll case has high economy on account of the water passages being designed so as to give a proper increase in velocity before the water enters the runners.

There are many other types of flumes, such as the cone shaped type. This type has ordinarily high economy, but has the disadvantage of a bearing which is not readily accessible.

Consideration must be given as to whether the inlet of the unit is to be beneath the floor line or above; the general question of accessibility of the various parts of the unit, the location of the governor, and many other points must be given attention. Racks of ample area must be provided at the intake in order that there may be low velocities through same and little loss of head. The pipe line must have careful consideration and proper velocities must be selected.

In plants with long pipe lines, the speed regulation and the consequent pressure variation is of great importance, as the latter has to do with the strength necessary and, therefore, the design of the pipe line. In some cases, pressure regulators are necessary. Again, surge tanks may be used. The draft tube must have proper attention and the tail-race be such as to give low velocities. If the tail-race is restricted, the total head is affected.

In order that the purchaser and water wheel manufacturer may have at hand when the wheel is being designed data covering all of the points which should enter into the design, it has been thought advisable to give a list of questions which should be filled out as completely as possible by the purchaser and sent to the manufacturing company for use when making his wheel.

Data to be Given to Water Wheel Manufacturer.

1. Number of units.
2. Horse power of water wheels.
3. Kw. of generator.
4. Total head.
5. Open flume or closed flume.
6. If closed flume, what is number of pipes?
7. What kind of pipe?—wooden stave, steel or concrete?
8. Diameter of pipes.
9. Effective head (unless design of all water passages to and from wheel is left to water wheel manufacturer).
10. Head water elevation.
11. Floor elevation.
12. Tail water elevation.
13. Head variable, if so, what is normal operating head?
14. If head is variable, what is the range of variation?
15. How important is power and economy at lowest head?
16. Speed of generator, if already decided.
17. If speed of generator is not decided, name speeds which seem to purchaser most desirable, and ask recommendations.
18. Flywheel effect of generator.
19. What speed regulation is desired for different load changes?
20. Will units run in parallel with other plants? If so, give general characteristics of such plants.
21. If running in parallel with other plants, can these plants be used to regulate the system?
22. What is the character of load factor?
23. What is the nature of water (silty or clear)?
24. What date shipment of material is desired?
25. Advise if it is expected that manufacturer shall furnish governor.
26. Give sketches of power plant site.
27. Give information as to what is to be expected in the way of guarantees.
28. Give any other information which you think would influence the design of the wheel.

It will not be attempted here to outline the specifications which should be made out to cover the purchase of the water wheel unit, but a list of data which should be supplied by the water wheel company is offered.

Data to be Supplied to Purchaser by Water Wheel Manufacturer.

1. A check of the calculation on effective head.
2. Horse power guarantee at normal head.
3. Guarantee at other heads, if head is variable.
4. Speed guarantee, including runaway speed.
5. Recommendation for best speed if same has not been determined.
6. Speed regulation guarantees.

7. Efficiency guarantees at full load, ¾ load and ½ load.

8. Point of greatest efficiency of wheel and value of same in per cent.

9. Efficiency guarantees for available head conditions.

10. If water wheel manufacturer furnishes governor, give information as to the type, make, power required to operate same, also what variation in speed will not be exceeded before the governor will begin to readjust gates to meet a change of load, either gradual or sudden.

In what time will governor completely open or close gates?

Within how many seconds will the speed of the unit be restored to normal?

11. Complete drawings showing machinery proposed.

12. Complete description of machinery proposed.

13. Guarantee of durability.

14. Guarantee of shipment.

Conclusion.—In submitting for your consideration the foregoing, I have endeavored to impress upon you the importance of giving careful attention to a number of principles which enter into the selection of a water wheel unit. It is quite possible that the ideas of the writer on a number of points which have entered into this discussion may not altogether agree with those entertained by others. He has, however, laid stress upon points which in practice he has found of value in selecting water wheels. It is hoped that the subject matter will form the basis of a beneficial discussion of this most interesting subject.

VISIT OF BRITISH CAPITALISTS.

A recent report from Ottawa states that arrangements have been completed for the visit to Canada of from 50 to 60 British capitalists, business men and manufacturers, representing, all told, something like two hundred millions. Conferences have taken place between Hon. George Foster and Mr. Leonard Palmer, of London, the originator of the trip. The party will include representatives of the London Chamber of Commence, several British Boards of Trade, Vickers, Limited, Birmingham Small Arms Co., Commill, Laird and Co., and other big British industries.

They will sail from Liverpool on the "Empress of Britain" on May 31st, and will arrive on June 6th at Quebec, where they will be officially welcomed to the Dominion. After a brief stay in the ancient capital they will proceed to the Maritime Provinces, where a week will be spent in inspecting the resources of that portion of the country. Arriving at Montreal about June 15th, they will afterwards proceed to Ottawa, where the visitors will be given an official welcome by the Dominion Government. They will subsequently visit Toronto and the chief points in Ontario, including Niagara and the Cobalt camp. Then, proceeding west, the party will make an extensive tour of the western provinces and of British Columbia. The visitors will again be in Montreal about July 19, and will sail for Liverpool, where they are due to arrive about July 27, after a tour of 42 days in Canada. The various Boards of Trade as well as the civic authorities throughout the Dominion have already taken steps towards giving the visitors a welcome.

The Quebec Harbor Commission has decided on building an elevator of one million bushels' capacity, of concrete and steel structure, with links that can be extended and developed so as to store two million bushels of grain, together with the construction of two piers on the Louise Embankment.

OIL-BURNING LOCOMOTIVES.*

By R. Godfrey Aston, of Rincón Antonio, Oax., Mexico.

The object of this paper is to give an account of liquid-fuel burning in the locomotives of the Tehuantepec National Railway, showing some of its advantages over coal, and giving a general description of facilities for handling and storing this fuel-oil, the methods of burning it, and a few results gained, which are taken from the monthly performance of locomotives. The author does not intend to deal fully with costs, &c., as it is too large a subject for so short a paper, but will confine himself to a more practical point of view.

The Tehuantepec Railway is a trans-continental line of standard gauge (4 ft. 8½ in.), 304 km. (189 miles) long, running across the Mexican Isthmus of Tehuantepec from the port of Puerto Mexico (Coatzacoalcos) on the Atlantic, to the port of Salina Cruz on the Pacific, with grades varying from level to 2.15 per cent., and abounding in curves up to 11 deg. 28 sec., or 100.10 metres radius, and where the speed of trains is limited to 24 km. (15 miles) per hour.

Storage Facilities.—All fuel-oil for the company is received at the terminal of Puerto Mexico, where the main storage tanks are situated; these comprise three cylindrical steel tanks, each composed of six tiers of steel plates riveted together and a light steel roof, with three manholes, and a ventilator in the middle, through which gases arising from the oil can escape. Two of these tanks are 95ft. in diameter and 37 ft. 6 in. deep, each with a capacity of 46,996 barrels of 42 U.S. gallons (35 British gallons).† The third tank is 92 ft. in diameter and 29 ft. 9 in. deep, and has a capacity of 35,138 U.S. barrels.

These tanks are all enclosed in separate earthen embankments and are connected together by an 8-in. pipe-line, which enters the tanks 1 ft. 6 in. from the bottom, this space being required for water, &c., settling out of the oil, and which can be drawn off through a 3-in. valve at the bottom of the tank. The pipe-line runs down to the wharf, where it is fitted with an 8-in. check-valve, and it is from there that vessels delivering cargoes of oil can pump straight into any tank, the two largest tanks being about 2 km. (1¼ miles) from the wharf. At convenient places in the pipe-line near to the round-house are stand-columns for filling engine-tanks, tank-cars, &c., and near the round-house is also a supply-tank of 28,000 U.S. gallons capacity, erected upon a structural steel frame, also used for giving oil to engines, &c.

The terminal of Salina Cruz is laid out in the same manner, except that there are only two storage-tanks, 95 ft. diameter and 37 ft. 6 in. deep, of 46,996 barrels capacity. The capacity of all these storage-tanks has been calculated out in U.S. barrels of 42 gallons for every 6 in. of depth, allowance being made for all internal stays, supports, &c. The fuel-oil is shipped from Puerto Mexico to the other fuel-stations in specially constructed double-truck steel-frame tank-cars of 6,600 U.S. gallons capacity, the gallons per inch of depth of these cars being known, so that the exact amount contained in each car can be credited to the station to which it is shipped.

Fuel-Oil.—The fuel-oil used by this company is purchased from the Texas Company, of Port Arthur, Texas, at

* Paper read before the Institution of Mechanical Engineers.

† 1 U.S. gallon = 231 cub. in. 1 British gallon = 277.27 cub. in. U.S. gallon = 5/6 British Imperial gallon. The value of the Mexican dollar is assumed throughout this paper to be 2s.

about 97½ cents gold per barrel of 42 U.S. gallons, delivered at Puerto Mexico and pumped into the railway company's tanks by the delivering vessel. This fuel-oil is generally delivered in tank steamers, sometimes towing barges, which come right up alongside the railway company's wharf; the coupling between the vessel and the company's land-pipe line is made with a flexible rubber or steel hose, which is supplied by the vessel.

This fuel-oil is quite thin and flows readily through pipes of any diameter; it is sometimes nearly black in color, and sometimes a dark brown with a green fluorescence. The railway company stipulates in its contracts with the Texas Company that the flash-point (closed) shall not be under 110 deg. Fahr., as a lower flash-point than this is liable to be dangerous, on account of the volatile gases and fumes which arise from the oil at comparatively low temperatures, and the author has seen the oil catch fire from a torch which was some 10 ft. or 12 ft. away from it. Some oils may be used in the crude state as fuel, while others have to be passed through the refinery; after the lighter oils, &c., have been taken off, the by-product or residuum is used in a satisfactory manner as fuel, and as such has been, and is, used in Mexico. Fuel-oil contains no power of spontaneous combustion, and, unlike coal, does not deteriorate if stored in tanks or reservoirs.

The specific gravity of this oil varies from 0.790 to about 0.942, and its weight per U.S. gallon from 6.4 lb. to 7.75 lb. The British thermal units vary from 17,000 to 20,000, the average being from 19,500 to 19,800, and between this and the best steam coal there is a very great difference. The analysis of two samples of the oil as used by this company for fuel is as follows:—

	No. 1.	No. 2.
Specific gravity at 60 deg. Fahr.	0.931	0.881
Baume Gravity at 60 deg. Fahr.	20.5 deg.	29 deg.
Flash-point (closed)	130 deg. F.	135 deg. F.
Flash-point (open)	160 "	160 "
Fire test	220 deg. Fahr.	224 deg. Fahr.
Setting point	3 "	20 "
Viscosity at 100 deg. F.	200 seconds (Redwood)	78 seconds (Redwood)
Sulphur	0.77 per cent.	0.26 per cent.
Calorific value	10,688 calories	11,000 calories
Color	Dark brown	Dark brown
Water and dirt	1 per cent.	0.25 per cent.

The standard temperature for the measurement of fuel-oil is 60 deg. Fahr., and expansion is allowed for at the rate of 1 per cent. for every 20 deg. Fahr. increase in temperature above 60 deg. Fahr., and contraction at the same rate for decrease in temperature below 60 deg. Fahr.

Locomotives.—The locomotives in use on this road are of the Baldwin consolidation type, the main dimensions of which are:—

Cylinders	20 in. by 26 in.
Wheel (drivers)	53 in. diameter on tread
Fire-box	Length inside, 108in.; width inside, 33½ in.
Flues	239 of 2 in. outside diameter
Grate area	24.94 sq. ft.
Heating surface	Fire-box, 147 sq. ft.; flues, 1,700 sq. ft. Total, 1,847 sq. ft.
Boiler pressure	170 lb. per sq. in.

The oil-tank is fitted into the coal-space of the tender, and its contents calculated for every ½ in. of depth. Most oil-tanks have a capacity of 2,000 gallons, and the oil is fed from the tank to the burner or atomizer through suitable connections and flexible brass ball-joints.

Fire-Box Arrangement.—The company's practice, after trying various types of burners and atomizers, is to use what is called a "front-end burner," that is, the burner-mouth points towards the back of the fire-box or fire-box door-plate; the burner is placed, in a 9-ft. fire-box, 4 ft. 2 in. from the flue-sheet, the flame playing against a brick wall built up to the level of the fire-box door opening. Between this brick wall and the fire-box back-plate is a 4 in. air-space extending the whole width of the fire-box and right up to the top of the brick wall. Brick walls are built up on each side of the fire-box from the height of the brick wall at the back, gradually sloping downwards; the floor of the grate or ash-pan is laid all over with fire-brick. No brick arch or baffle-plate is used.

As mentioned in the preceding paragraph, the burner is placed 4 ft. 2 in. from the flue-sheet, and midway between the sides of the fire-box, so that both in front and behind the burner or atomizer there is a flat bricked-over area of fire-grate; and as the burner is placed parallel to the lower grate, there is a 4-in. space between the front and back grates, this 4-in. space being left open to admit air, extending from one side of the fire-box to the other.

Brickwork.—This should be of the very best material and workmanship, as it is subject to a much greater heat than from a coal fire; if this is not done, the walls will not stand, and engine failures will occur; moreover, the failure of only one brick will perhaps necessitate new brickwork throughout, thus needlessly running up expenses. There is no reason why the brickwork should not stand from four to six months, and perhaps longer, if due care be taken from the start.

A good brick should contain about 80 to 85 per cent. of silica and from 20 to 15 per cent. of alumina, and should be as free as possible from alkalis, which cause fluxing. A good brick becomes surface-glazed though remaining rough and porous; it should be perfectly dry when built up in a fire-box, otherwise the heat will cause it to crack; if possible, the fire-bricks should be fired at a temperature as high as that to which they will be exposed when in use.

Burner or Atomizer.—There are many and various kinds of hydro-carbon burners, and after a trial of various types, including the Baldwin and "Best" burners, this company is using with considerable success a burner which is made in their own shops, and which is really an inverted "Best" burner. It is a simple device, which allows the oil to fall from an orifice 3 in. wide by 9/16 in. deep over the top of a flat steam-jet 3 in. wide and 1/32 in. deep, the steam picking up the oil and sending it into the fire-box in the form of a spray; the underneath jet of steam delivers the spray of oil at an angle so that it strikes the brick wall in the middle, instead of shooting out from the burner parallel with the bottom of the ash-pan. This burner may be called an outside atomizer, and although it is in general use, it has its drawbacks; but it has been found to be more efficient than any other they have used.

The most essential points about a burner or atomizer are:—

1. Its atomizing capacity. All fuel-oil is heavy, and will burn in the form of a vapor or spray only when mixed with air. The object should be to fill the fire-box with a soft and voluminous flame, and not to impinge it in any one place.

2. Its facility for keeping clean and free from clogging.

3. Its adjustability in giving the right direction to the flame or spray, and regulating the proper proportion of oil and the agent, either steam or air, used for atomizing.

A burner which will vaporize or atomize the oil at the point of expansion of the agent used for that purpose, and

which is easily handled, and which will atomize the greatest amount of fuel with the least possible energy, is the highest and most efficient that can be designed. On this railway steam is used as the atomizing agent, because, after various experiments, it was found to be superior to air. The steam to a very great extent heats the oil as it flows into the burner before delivery in the form of a vapor spray. The flame from the burner should not be too long, or it will pass into the flues and become extinguished. Gases which are only partly consumed will re-light in the smoke-box.

Lighting up an Oil-Burning Engine.—In each round-house of this company is a stationary boiler, always in steam, used for the washout and other pumps, as well as for lighting up dead engines. From this boiler is laid a 2-in. steam-line to points between each engine road or stall. From there a connection can be made to a locomotive through a three-way cock or T-piece in the steam-pipe leading from the steam-stand on top of the fire-box to the burner; by use of this steam the burner can be started and kept going until the boiler has generated enough steam to keep the burner going itself. A piece of oily waste is lighted and thrown into the fire-box just in front of the burner from which the spray ignites. Connections can be made to any other engine all ready in steam should the stationary boiler not be available for any reason.

Firing and Cleaning Flues on Road.—With an oil-burning engine there is always a fire of equal intensity and one which never gets dirty, so that good steaming is practically ensured. It is a popular idea that it is a very easy matter to fire an oil-burning engine, but this is not the case, as both skill and care are required, so that the author thinks it best to lay down a few of the most important rules:—

1. See that the oil-tank is full, and if heaters are used, that they are in operation, and that the temperature of the oil is as it should be.

2. See that the sand-box on the foot-plate is full, and that the scoop is in its place.

3. Before starting the fire see if the temperature of the fire-box is below igniting point, which is a dull red, and if so, open dampers (if used), start the blower, and open the atomizer-valve fairly hard; then put a piece of saturated oily waste on the bottom of the grate after setting it alight, close the dampers (if used) and fire-box door, and turn on the oil very light. When the oil has ignited, reduce the blower and atomizer to a light feed, also the oil until the chimney is quite clear of smoke.

4. See that the fire is burning brightly, and that there is no oil on the bottom of the pan, also that the brickwork is in good condition, and that no bricks or any other obstructions are on the bottom of the grate or pan so as to obstruct the flame or jet on its way from the burner to the brick wall.

5. As regards cleaning flues on road, it is best to sand frequently if the engine is being worked hard—say every 15 km. or 20 km. (9 or 12½ miles); but if the engine is being worked light, every 50 km. or 60 km. (31 or 37 miles) will be sufficient.

6. Having attained a fair rate of speed, fill the scoop with about a quart of sand, close dampers (if used), and put reverse-lever near full stroke, then open regulator wide, insert the end of the scoop in the round hole in the fire-box door, and allow the sand to be drawn out of the scoop through the fire-box and flues and out of the chimney; sanding is best done when the engine is working hard up a grade.

7. Black smoke shows incomplete combustion, and should never be allowed to be emitted from the chimney, as it only fills up the flues with carbon, besides being a non-conductor of heat, and it is also a great waste of fuel. If a bluish-colored smoke or fumes are seen coming from the chimney, it is a sign that the burner is cut down too fine.

8. When putting out the fire the oil-valve should always be closed first, then the atomizer-valve (in their case steam), then the blower. The oil-valve is always the last to be turned on and the first to be turned off.

9. Never go near an open tank with a lighted lamp or torch, as at any time an explosion may occur, especially if the oil used has a low flash-point.

Round-House or Shed Work.—An oil-burning engine has a great many advantages over a coal-burner, but this is specially noticed in the round-house or shed when squaring up an engine after a day's run; there are no fires to be raked out, no flues or smoke-box to be cleaned (the smoke-box door of an oil-burning engine need be opened only once every three or four months for cleaning purposes); there is no coal to be sacked, weighed, or otherwise handled, and oil-burning engines do not carry fire-rakes, prickers, flue-brushes, shovels, or picks, so that all these things, besides other minor details, represent a great saving in engine equipment.

Among other advantages are the rapidity with which steam can be raised, and the facility with which the boiler can be forced when greater calls are made; the author has in a special case of necessity raised steam in a dead engine to a pressure of 130 lb. per sq. in. in 50 minutes from cold water, without any serious effects on the boiler, whereas in in a coal-burner from 2 to 3½ hours is needed to raise steam if no jet from a live engine is used.

Another very great advantage is in switching, or shunting, or standing pilot, when engines frequently have to stand in steam for hours at a time. The burner can then be cut down or extinguished, thus effecting a great saving in fuel, as an engine will always retain a sufficient amount of steam to start the burner or atomizer again; and any danger of the fire-box or crown-sheet being injured through the water getting too low is entirely obviated. The heat lost while standing is the same whether coal-fired or oil-fired.

Effects of Oil-Burning on Fire-Box, Flues, &c.—Oil-burning is no more injurious to a fire-box or flues, &c., if ordinary care be used, than coal-burning; in fact, from the author's experience, it is not so hard on a fire-box as coal-burning, for it is quite noticeable in the fire-boxes of coal-burning engines that stay-heads, plate-edges, flue-ends, and crown bolt-heads show signs of wear, corrosion, or burning, but in their oldest oil-burning engine not any of these signs are noticeable, everything being clean and in good condition.

This company uses steel boxes with wrought-iron tubes and copper ferrules. A set of tubes will last, and remain perfectly tight, from 2½ to 3½ years, when they may have to be taken out to be re-ended; some of the engines are working to-day with tubes over four years old, many of which are as tight as they were on the day they were put in. Some of the wrought-iron tubes are being replaced by mild steel, because, after the holes in the tube-sheet get worn, tubes of steel stand the expanding better; but at present those that are in service have not been in use long enough for one to form an opinion of them as compared with wrought iron.

Some people are of the opinion that more than 2 per cent. of sulphur in fuel-oil is injurious to the fire-box, but as the amount of sulphur in the Texas oil the company has been using is below 0.75 per cent., no ill-effects have been noticed; but as there are coals which show as high as 3.5 per cent. of sulphur, the author does not see why sulphur should be more injurious in oil than in coal.

Engine Performance.—Although the engine tonnage has practically doubled since 1908, the author gives the following statistics for each month from January, 1907, to August, 1911:—

(1) Cost of fuel-oil per barrel of 42 gallons (Mexican currency);

(2) Cost per kilometre for fuel (Mexican currency); and

(3) Kilometres run per barrel of oil;

but it must be understood that since about the middle of 1909 all engines are loaded down to their capacity, single trains averaging 750 to 800 tons behind the draw-bar. As the road-bed is by no means level, helper engines are used over certain sections where the grades are long and heavy, so that this will explain the decrease in kilometres run per barrel of oil between 1908, 1909, 1910, 1911, as the tonnage per engine has been increased to the maximum.

Oil-Fuel. Monthly Averages.

During.	Cost of Oil per Barrel.		Cost for Fuel.		Distance Run per Barrel.	
	Dollars (Mexican).	Shillings.	Cents per Km.	Pence per Mile.	Km.	Miles.
1907	2.585	5.17	28.476	10.99	9.546	5.928
1908	2.357	5.91	27.151	10.48	11.04	6.855
1909	2.502	5.01	25.19	9.73	9.999	6.209
1910	2.356	4.71	25.02	9.66	9.41	5.843
1911 (8 months).	1.990	3.98	22.23	8.58	8.89	5.520

The cost of fuel-oil per barrel of 42 U.S. gallons (231 cub. in.) as charged out every month is made up of the following items, and also depends upon whether there is any shortage or overage when the inventory is taken at midnight on the last day of each month; this accounts for the variation in prices:—

1. Price of oil per barrel f.o.b. in ships' tanks at delivering port (Puerto Mexico).

2. Commission to purchasing agents in United States.

3. Consular invoices.

4. Inspection fees for inspecting cargo in ships' tanks at shipping point.

5. Stamps.

Items 2, 3, and 4 only refer to oil purchased out of Mexico.

Based on tests which have been made, the company reckons 3½ barrels, or 147 U.S. gallons, of oil as being equal to 1 ton of coal or 1,000 kg., or 2,204 lb. or 3½ barrels of oil equal one unit of fuel.

The author is unable at this time to give any reliable data of fuel consumption on a tonnage basis, as no records are kept of the company's freight hauled over the road, although it is considerable; but the average loaded passenger and freight cars hauled 1 kilometre per unit of fuel from January 1 to December 31, 1910, was 330.89, and from January 1 to June 30, 1911, 333.60. The average loading weight of freight-cars is approximately 30 tons.

In August this year (1911) the company received the first cargo of a native or Mexican fuel-oil, under a contract with the Campania Mexicana de Petroleo, El Aguila, S.A., at a price of 1.75 dols. (Mexican) (3s. 6d.) per barrel of 42 U.S. gallons delivered into railway company's tanks at Puerto Mexico. This oil, which is used in its crude state as fuel, is jet black in color, thick, and has a heavy asphalt base, and although the company has not used it sufficiently long to be able to compare it with the Texas oil, it may be of interest to state a few of the difficulties met with when first they began to use it.

As this oil is thicker than Texas oil, heaters have to be used in the engine-tanks, but it has been found that if this oil is heated up to about 150 deg. Fahr. (which can be done with Texas oil), great difficulty is experienced in getting the burner spray to light, and the oil settled very thickly at the bottom of the tank; it would not run through the pipes to the burner, and could only be burned effectively by mixing a fresh supply of oil with it. In order to burn this Mexican native oil successfully, it requires to be only just warmed. When using this, a large piece of carbon or coke-like substance is formed in the fire-box, and grows up from the bottom of the pan or grate directly under the burner-mouth. This may vary from 6 in. by 4 in. by 4 in. to 12 in. by 10 in. by 8 in. in size, growing up in such a manner as almost to smother the burner-mouth. The analysis of this substance is as follows:—

	Per cent.
Ash	1.25
Sulphur	7.89
Carbon	90.86
Asphalt	nil

It shows to a certain extent, that there is incomplete combustion, which can be remedied by admitting more air; but this cannot very well be done without affecting the steaming qualities of the engines. However, by raising the burner slightly, these lumps of carbon have decreased in size, and it is hoped eventually to adjust things in such a manner as to prevent their forming at all.

The analysis of two cargoes of this Mexican crude fuel-oil is as follows:—

	No. 1.	No. 2.
Specific gravity at 60 deg. Fahr.	0.944	0.942
Baume gravity at 60 deg. Fahr.	18.4 deg.	18.8 deg.
Flash-point (closed)	78 deg. Fahr.	102 deg. Fahr.
Flash-point (open)	104 "	120 "
Fire test	165 "	180 "
Viscosity at 100 deg. Fahr.	1080 seconds (Redwood)	920 seconds (Redwood)
Sulphur	3.44 per cent.	3.35 per cent.
Calorific value	10,971 calories	10,610 calories
Color	Black	Black
Water	Nil	0.5 per cent.
Asphalt	—	37 "
Carbon (coke)	—	12 "

It may be explained that the 37 per cent. asphalt is obtained by distilling off the distillates from the crude until only 37 per cent. residue is left, which consists of asphalt. The 12 per cent. coke is obtained by distilling this 37 per cent. down to 12 per cent. residue (on the crude); so that if they get 37 per cent. asphalt, they do not get the 12 per cent. coke; and if they get the 12 per cent. coke, they do not get the 37 per cent. asphalt.

The author regrets that at this time he is unable to go deeper into this subject, but he hopes that what little information he has been able to give with regard to oil-fuel burning in the Tehuantepec locomotives will be of interest to others working in the same direction.

The Port Colborne and St. Lawrence Navigation Co., Limited, has purchased the SS. "Algonquin" and "Cataract" as the nucleus for a new lake line of wheat and flour carriers. The former will take flour, for which her capacity is 2,700 tons, from the Maple Leaf milling plant at Port Colborne to Montreal. The "Cataract" will be used, for a time at least, in Montreal as a barge. We understand more boats will be built or purchased. This enterprise is looked upon as the carrying out of Mr. Hedley Shaw's intimation at the time of the opening of the big mill at Port Colborne that the Maple Leaf Flour Milling Co. might do well to establish its own line of boats, owing to the discrimination in rates made by the railways against shipments of flour compared with wheat. The management of the navigation company is largely identical with that of the milling company, Hedley Shaw being president, John Carrick secretary, and Cawthra Mulock, W. D. Robertson, C. W. Band and E. H. Laschinger being directors.

CHICAGO CANAL WATER DIVERSION.

The Great Lakes, which constitute the mose extensive navigable inland waterway in the world, have already had their levels permanently lowered to an extent which has resulted in serious loss to navigation and other interests. These changes in levels have occurred because waters which under natural conditions, would have reached the sea by way of the St. Lawrence River, have, instead, been diverted through an artificially constructed channel at Chicago, and, thereby, made to reach the sea by way of the Mississippi valley.

This loss in levels is a matter of national concern both in the Dominion of Canada and in the United States. As it is one of momentous importance to citizens of both countries, an intelligent understanding should be had of the facts relating to the whole matter. The Department of Marine and Fisheries of Canada has sent out a brochure entitled "Papers Relating to the Application of the Sanitary District of Chicago for Permission to Divert 10,000 cu. ft. per sec." A short abstract of the pamphlet is given here.

The need for conserving the integrity of the levels of the Great Lakes has long been appreciated and, in 1909, was made the subject of treaty between Great Britain and the United States. This treaty, known as the Boundary Waters Treaty, provides that no diversion from the boundary waters between Canada and the United States shall be made without the express authority of the governments of both countries, and corresponding provision is also made in the treaty respecting the diversion of other waters which materially affect the levels or flow of boundary waters. The present diversion of water through the Mississippi Valley, is one which materially affects the level and flow of boundary waters and, consequently, has become a subject for international consideration.

The diversion under discussion, had its origin in the sanitary needs of the city of Chicago. Chicago was confronted with the urgent necessity of disposing of her sewage in a manner that would prevent contamination of her water supply.

Two sluggish streams, the North branch and the South branch of the Chicago River flow through the city approximately parallel to the shore of Lake Michigan, to the main Chicago River which—since the diversion—flows westward from Lake Michigan. For many years, the sewage of the city was discharged into these streams, and, at least as early as 1860, the offensive condition of the South branch attracted official attention. The first complaints arose, not on account of contamination of the water supply, but on account of the offensive odor. In 1862, high water in the river, and lowering of the lake level by wind, resulted in arousing complaints respecting the foul smell and taste of the water supply.

In 1871, the situation was partly relieved by cutting down the summit level of the Illinois and Michigan canal—connecting the Chicago and Desplaines Rivers—and drawing the water for the canal from Lake Michigan. Later, it was found necessary to install pumping machinery, at Bridgeport, to maintain a current westward through the South branch and the Illinois and Michigan Canal. In 1874-80, another pumping plant was constructed to pump water from the lake, through the Fullerton Avenue conduit, into the upper waters of the North branch.

In 1880, after twenty-five years of struggling to get rid of her sewage and prevent contamination of her water supply Chicago was still looking for some means of purifying the river from its filth, and preventing a repetition of the great epidemics of 1848 and 1854, which had led to the construction of the first system of sewers.

To meet these conditions, Chicago, in 1889, decided to adopt an extensive sewage scheme employing what is known as the dilution method. This method was selected because it was believed that, if sufficient water could be readily and cheaply obtained, this method would be an economical one for Chicago. The dilution method consists essentially of diluting sewage effluent with sufficient water to render it inoffensive. In the case of the Sanitary District of Chicago, this proportion has been established by a State law which fixes it at one cubic foot of water per second for each 300 of population. On this basis, a population of 3,000,000 would require 10,000 cubic feet per second—an enormous amount of water and comparable to the mean quantity passing over the American fall at Niagara. Lake Michigan—an integral part of the Great Lakes system—and practically a unit with Lake Huron and Georgian Bay—afforded a possible source of supply and was tapped by Chicago.

A corporation, known as the Sanitary District of Chicago, was formed under a special Act of the State of Illinois, and empowered to undertake the construction and operation of the works necessary for the new projects. The enabling Act, entitled "An Act to create sanitary districts and to remove obstructions in the Desplaines and Illinois Rivers," was passed May 29, 1889, and came in force July 1st of the same year. The Sanitary District comprises an area of 358 square miles.

One of the first works to be constructed was a large artificial channel, known as the Chicago Drainage Canal, extending from Robey Street in Chicago, to Lockport, Ill., a distance of 32 miles. By means of this channel, water from Lake Michigan flows westward through the Chicago River—whose flow has been reversed—to the canal, and is discharged into the Desplaines River at Lockport. The canal was designed to carry 10,000 cubic feet of water per second, but was constructed to carry 14,000 c.f.s.

The canal was opened on January 17, 1900. Water from Lake Michigan then flowed through Chicago by way of the Sanitary canal into the Mississippi. As a high-water cycle in the Great Lakes followed the diversion, the injurious effects were not, at first, apparent. In 1909, a low-water cycle commenced and, in 1911, the level was only a few inches above the level of 1895—which, with the exception of 1819, is the lowest water ever recorded. The knowledge that a part of the loss then experienced, was due to the diversion at Chicago, effectually aroused navigation and the allied interests who were thus injuriously affected by the selfishness of Chicago.

The United States Secretary of War is vested with jurisdiction over, and discretionary powers appertaining to, the navigable waters of the United States. As the new flowage of water through the Chicago River affected navigation at the port of Chicago, it became necessary for the Sanitary District to apply to him for permission to divert the waters it proposed to use. The secretary authorized the diversion of a certain quantity of water and, after subsequent modifications, a permit was issued, fixing the amount authorized for diversion at 4,167 cubic feet per second. The Sanitary District, however, did not confine its use of water to the quantity authorized by the Secretary of War. A special board of engineers, under the chairmanship of Brig. Gen. W. H. Bixby, chief of engineers, was appointed to report upon the effect upon navigation of diversion at Chicago. The special board reported that the Sanitary District was diverting some 7,000 cubic feet of water per second, thus exceeding the authorized amount by 3,000 c.f.s.

It was proposed, in connection with the Chicago drainage canal, to construct a navigable waterway from Chicago,

by way of the Mississippi Valley, to the Gulf of Mexico. General Bixby has reported that 1,000 cubic feet of water per second would be ample for purposes of navigation.

A large amount of power can be developed from waters diverted by the drainage canal, and along the course of the proposed navigation route. The development, and sale, of this power would create a large revenue, and, in connection with this project, the Sanitary District and other interested parties, have entertained the hope, and expressed the expectation, that profits derived from the sale of hydro-electric energy, developed by means of waters diverted through the canal, would meet the whole expenditure on the Lakes-to-the-Gulf Deep Waterway.

It will be recognized, therefore, that this development of cheap power, coupled with the method of sewage disposal, has been a very strong incentive for Chicago interests to obtain all the water possible.

On the 5th February, 1912, the Sanitary District requested permission from the Secretary of War "to withdraw from Lake Michigan through the Chicago and Calumet Rivers—not to exceed 10,000 cubic feet of water per second". The Government of Canada was notified that the Hon. Henry L. Stimson, U.S. Secretary of War, would hold a hearing at which those interested might make statements relating to the effect which the proposed increased diversion of water at Chicago would have upon their respective interests. In accordance with this notification, the Hon. J. D. Hazen, Minister of Marine and Fisheries, Canada, appointed a special committee to prepare a case on behalf of the Dominion of Canada. This committee, consisting of Messrs. Daniel Mullin, K.C., A. St. Laurent, W. J. Stewart, V. W. Forneret and John Kennedy, was appointed by Order in Council dated March 27th, 1912. The report and recommendations of this special committee are embodied in the brief and counter-brief which have been submitted to the U.S. Secretary of War on behalf of Canada.

At the first hearing, held at Washington on February 28, 1912, representations for, and against, the application were made by citizens of the United States. A second hearing was held, also at Washington, before the Secretary of War, on March 27, 1912, when protests were made on behalf of the Government of Canada, the Commission of Conservation, the Dominion Marine Association, the Montreal Board of Trade, the Montreal Harbor Commission, the Toronto Harbor Commission and others.

A request was made on behalf of the Government of Canada that the application of the Sanitary District of Chicago to increase its diversion from Lake Michigan be not granted and, that any abstraction of water from Lake Michigan be limited to such quantity as shall not injuriously affect navigation and other interests on the Canadian side of the boundary.

After the hearing of March 27, 1912, the Secretary of War announced that seven days would be allowed the trustees of the Sanitary District to file their brief—the Dominion of Canada to file its counter-brief, not later than April 16th.

The argument for Canada, together with the brief for Canada, and the brief of Mr. J. C. Williams, counsel on behalf of the trustees of the Sanitary District of Chicago, and also the counter-brief for Canada, all as submitted at the respective hearings, are given below in full. The memoranda and statements made by various organizations represented at the hearings, including that of the Commission of Conservation of Canada, are also published herewith.

As a result of carefully weighing all the testimony of the navigation and other interests which have been adversely affected by the lowering of the levels of the Great Lakes, and the testimony adduced before the Secretary of War, and, also, the other available data bearing on the subject, the special committee appointed by the government of Canada unanimously reached the following conclusions:

(1) That there is no imperative necessity for such a large diversion of water from Lake Michigan for sanitary purposes, as is requested in the application.

(2) That the historical facts presented in this brief show conclusively that the sanitary canal can not be considered as the outgrowth and development of a scheme which has received recognition by the United States government, or that of the Dominion of Canada.

(3) That the claim that the Sanitary District is entitled, as a matter of right, to the use of so much of the waters of Lake Michigan as may be necessary for sanitary and domestic purposes, cannot be entertained in so far as it relates to the extraordinary and wasteful use proposed.

(4) It has been shown that very substantial injuries have been made, and are being suffered by navigation interests. Fears for future and more extensive damages, by reason of increased diversion, are exceedingly well founded, and justify the demand that some improved method of sewage disposal, which shall not require the abstraction of any considerable quantity of water from Lake Michigan nor the diversion of other outlets of water which would naturally flow into it, be adopted.

(5) That the Dominion of Canada has the right to a voice in the disposition of the waters of Lake Michigan for sanitary purposes in so far as such diversion injuriously affects navigation, because her citizens are accorded, by treaty, the right of free navigation in that lake, and, in that no diversion can be made without injuriously affecting her harbors, channels and canals.

(6) It having been shown that the sewage of Chicago can be so treated and disposed of by other means than the present dilution methods, by which great quantities of water are withdrawn from Lake Michigan and discharged through the Drainage canal into the Illinois River, it is contended on behalf of Canada, that the abstraction of water from Lake Michigan shall be limited to such quantity as shall not injuriously affect navigation interests on the Canadian side of the boundary, and, that such limitations shall take effect at the end of such time, as, in your judgment, may be reasonably necessary for the Sanitary District to instal, and put into use, the works which may be required for disposing of the sewage by other means than by the dilution method now in use.

(7) That, in view of the fact that the Sanitary District claims that permits hitherto issued deal only with the flow through the lower portion of the Chicago River, and that it has the right to take any amount of water, without permission, through the canal, provided it is supplied through other feeders, it is respectfully requested that all permits be only for such limited quantity of water as shall not injuriously affect navigation on the lakes and the St. Lawrence River, and be so worded as to state the total quantity which the Sanitary District of Chicago may be permitted to withdraw for domestic and sanitary purposes from the drainage basin of Lake Michigan.

We feel confident that the interests of humanity at Chicago, and the levels of the Great Lakes, and of the St. Lawrence River, can best be protected by the installation of a modern system of sewage disposal, rather than by using a method which has been shown to be injurious to the navigation and commerce of both nations, and, further, that the interests of the public generally will, thus, be protected and their welfare promoted.

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THE APPOINTMENT OF A HEALTH COMMISSIONER.

"A vacancy will soon exist in the position of chairman of the Board of Health of the city of Boston.

The duties of the chairman and his two associates are various and responsible. They embrace the control of contagious diseases, including bacteriological tests, disinfection, and preventive measures; the inspection of milk, vinegar, provisions, tenements, slaughter houses, stables and occupations and conditions dangerous to health; the medical inspection of the schools, containing more than 100,000 pupils; the management of a smallpox hospital and a quarantine station; the control of convenience stations throughout the city; the compilation and publication of vital statistics, and other miscellaneous duties. The department has over two hundred employees.

The mayor will consider applications from physicians, sanitary engineers, or other persons experienced in this field, who are American citizens."

Attention is called to the last paragraph of the above. Applications for the position of Health Commissioner for the city of Boston are being invited, and the above is clipped from the notice calling for applications. It is nearly time for our Canadian municipalities, when openings in civic positions occur, to include a paragraph similar to the above, with the change of "Canadian" for "American." In many municipal appointments made recently in our Canadian cities foreign engineers have received the positions. We have stated before in these columns our feeling that just as able men can be secured from the ranks of the Canadian engineering profession as elsewhere. Evidently, our neighbors across the line feel likewise concerning their own appointments, and have taken measures to ensure the appointment of citizens of the country. The sooner their example is followed in this matter, the better it will be for both the cities concerned and the engineering profession.

THE CONSULTING ENGINEER AND THE MANUFACTURER.

Of late years a practice has prevailed among contractors and manufacturing establishments of gratuitously preparing plans, furnishing estimates and giving advice on engineering work. This has been the cause of considerable adverse comment on the part of the engineer, for it interferes with his legitimate practice. At the last annual meeting of the American Institute of Consulting Engineers a discussion of this practice arose, and the consensus of opinion was that something should be done to stop it, as it was certainly unfair and detrimental, not only to the engineer, but also to the manufacturer and contractor. A number of interesting points were brought out during the discussion. Mr. C. C. Schneider stated that a few years ago, in tendering on steel work, the prevailing practice of making designs on speculation had it demoralizing influence, which did not seem to be sufficiently appreciated by purchasers of structural work, they being led to believe that the contractor did this work gratuitously. A moment's reflection, however, will show the fallacy of such an assump-

tion. The fact is that the manufacturer has to pay for making designs, not only once, but many times over, as only once in a number of cases is he the successful bidder. This extra expense must be paid by the purchaser. Now, however, it is becoming more and more the practice to let contracts for bridges and other structures on designs prepared by engineers employed by the purchaser.

Nevertheless, it is true that a great deal of work is done by the manufacturer which should logically come to the consulting and constructing engineer. The result is that the actual purchaser of the company's product is compelled to pay the expense of investigating other people's projects which are never carried out. At the present time the reinforced concrete practice is in about the same condition as that of structural steel work some years ago. It will only be by the co-operation of the engineering profession that this condition of affairs can be ameliorated. It was suggested at the meeting mentioned above that the different engineering societies whose members undertake consulting work should adopt a schedule of minimum charges, and that the companies manufacturing apparatus, in furnishing estimates, plans and specifications should regard themselves as consulting engineers, and invariably should exact for the service rendered at least the minimum charge recommended. This would, no doubt, help to kill the practice. It is to be hoped that some concerted movement will be taken with regard to this matter.

SELECTION OF A WATER-WHEEL.

At various times we have referred to the increased precision now obtained by the water-power engineer in the design and installation of water-power development. A number of factors have contributed towards this result. One of the most important of these factors is that more thought is being given to the application of precise methods in selecting the water-wheel unit. By a gradual process of development the water-wheels themselves have been brought to a very high state of efficiency for operation under various conditions of installation. Theory has begun to play a large part in the design of units for special conditions of head and amount of water, until now a highly specialized branch of engineering service has been reached.

With the more general use of electric power and the perfection of high voltage of transmission, many developments of Hydro-Electric power have become possible. These include very low-head plants and very high-head plants, with a wide range in the quantity of water available. Regulation demands are becoming more rigid. Expensive storage dams, with large reservoir sites, compel economy in the use of water.

These factors have aided in forcing the water-wheel manufacturer to furnish wheels for particular cases, and not from stock patterns. In order to furnish a wheel which will give the best results under the required conditions of service the designer must know certain facts. Mr. O. B. Coldwell, in a paper given recently to the American Institute of Electrical Engineers, and published in the last two issues of *The Canadian Engineer*, discusses the features entering into the particular design of water-wheel which will best reach the conditions for which it is intended, and points out the information which should be furnished by the purchaser to the water-wheel designer to enable him to plan the most efficient unit.

EDITORIAL COMMENT.

In this issue of *The Canadian Engineer* will be found the second part of the article describing the Red River Bridge for the National Transcontinental Railway. This is a bascule bridge of a new form, known as the "Heel Trunnion," and is a modification of the earlier form of bascule. This is the first description of the "Heel Trunnion" type that has as yet appeared in the technical journals, and will, therefore, be of considerable interest to our readers.

* * * *

Members of the engineering profession resident in Toronto will much regret City Engineer Rust's removal to Victoria, B.C. The integrity and uprightness which has marked his career throughout his municipal life has done much towards setting a proper standard for the engineering profession in Canada. At the same time we feel sure that the work of the Canadian Society of Civil Engineers and its influence in the West will receive an added impetus with the presence of the immediate past-president of the organization in Victoria. We wish Mr. Rust every success in his new sphere of action.

* * * *

We drew attention through our editorial columns recently to the application of the Sanitary District of Chicago for permission to divert an increased amount of water. The Canadian Government have very rightly taken a strong interest in the application, knowing the evil results that will accrue to Canada as the result of the granting of the application. To secure an intelligent understanding of the facts underlying and concerning the application, the Department of Marine and Fisheries has sent out a pamphlet giving the facts as known. An abstract of the pamphlet will be found in this issue.

GENERAL NOTES.

Precipitation was very generally in excess of the average in Canada during April, but in Vancouver Island and the Kamloops District of British Columbia, Saskatchewan and Nova Scotia, the usual amount was not recorded. The excess was pronounced in Alberta, where the fall was almost twice the normal in many localities.

At the close of the month the ground was bare of snow in most places, but in the bush region of Upper Ontario there was a depth of from four to twelve inches, and in the Gaspé Peninsula of Quebec about four inches.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for April, 1912:

	Depth in inches.	Departure from the average of twenty years.
Calgary, Alta.	2.00	+1.41
Edmonton, Alta.	1.60	+0.76
Swift Current, Sask.	0.4	—0.35
Winnipeg, Man.	2.20	+0.66
Port Stanley, Ont.	3.50	+0.92
Toronto, Ont.	2.74	+6.34
Parry Sound, Ont.	2.34	+0.20
Ottawa, Ont.	3.14	+1.26
Kingston, Ont.	3.27	+1.28
Montreal, Que.	3.20	+0.88
Quebec, Que.	3.13	+1.10
Chatham, N.B.	3.20	+0.45
Halifax, N.S.	3.90	—0.62
Victoria, B.C.	1.30	—0.50
Kamloops, B.C.	1.30	—0.52

A FLOWING WELL.

The illustration given herewith shows No. 2 borehole which was sunk at Boggy Creek for the purpose of supplying water for Regina, Sask. Mr. R. O. Wynne-Roberts, the consulting engineer, after a study of the geological formation, decided that there should be water at this point, and on sinking a well, a gusher was located. This well is 75 ft. deep, 5 inches in diameter, and at 8½ ft. above ground it is now discharging 440,000 gallons a day. At 8 ft. below ground it is expected to yield about 700,000 gallons daily.

View of Well Showing Measuring Weir.

A few months ago Regina had only a supply of one million gallons per day; now there are 2,750,000 gallons ready for the city, and it is hoped to increase this to a still larger quantity from Boggy Creek. The next well to be sunk will be 7¾ inches in diameter and it is expected to yield a greater quantity than the 5 inch well. The photo is of interest because it is rare that such powerful artesian wells are to be found in the glacial formation. These wells should place Regina in an excellent position with regard to industries and financial operations. The view shows a temporary V-notch weir installed to measure the flow of the well.

ELECTRIC SMELTING OF IRON ORE IN SWEDEN.

The Stora Kopparbergs Bergslags Aktiebolag, at Falun, who are the owners of the Domnarfvets Ironworks, at which works the first large electric smelting furnace was erected, are now going to build a new electric furnace with a capacity of 12,000 h.p. The earlier furnace was constructed according to the designs of the Elektrometals Company. The new furnace, however, is to be constructed in accordance with the patents of Dr. A. Helfenstein, of Vienna, and a contract with the inventor has already been signed by the company. The Helfenstein furnace, which is fitted with vertically adjustable electrodes, has been adopted in several places in Germany and France in the carbide industry, and is also used for the production of ferro-alloys, the size and capacity of the furnaces varying from 6,000 to 12,000 h.p. This is stated to be the first time, however, that the furnace is to be used in connection with the iron industry. Among the advantages claimed for it is the fact that the capital expenditure per h.p. is small, and further, that it is simple in design, and the cost of operation is low. It can also be adapted to a varying supply of energy, which is of particular importance to works depending for their energy supply upon rivers and waterfalls. It is expected that the new furnace will be completed in the autumn, and possibly results will be available before the end of the year.

CENTENARY OF GAS LIGHTING.

The year 1912 marks the one hundredth anniversary of civic street illumination by means of gas and its importance, even in 1812, may be readily noticed from the fact that its application to street lighting followed its first public demonstration by just nine years. Mr. Samuel Gleg, the first business manager of the National Light and Heat Company (London), improved the art to a great extent by the introduction of the hydraulic main, the wet lime purifier and the wet gas meter. With these improvements gas rapidly spread over the civilized world as an illuminant, and Baltimore had the honor of being the first city on the American continent to use it for street lighting purposes. This was in 1821. Boston followed the next year, and by 1827 gas lighting had become common in New York City.

At first no attempt was made by the gas producing companies to secure any other product from the coal than the gas, but later on it was discovered that there were several valuable by-products. The products of gas distillation contain vapors of tar and naphtha together with steam impregnated with carbonate of ammonia and sulphide of ammonia. These vapors condense in the pipes and clog them up. Instead of being considered a nuisance it is now recognized that they have a value, and add considerably to the assets of the gas companies. Sulphide of ammonia amounts to one per cent. of the coal treated, although some thirty per cent. of this amount is lost. However, it is worth nearly twenty dollars a ton as a fertilizer, and gas companies in regions where fertilizer is most in demand find a ready market for all the sulphide they can produce.

When electricity began to come into use as an illuminant it was predicted on every hand that the gas companies would soon become bankrupt, and that gas would be driven out of the market. These prophecies have been falsified, for gas companies are more prosperous than ever. They are concentrating much of their energy in popularizing gas as a heating agent, for up to the present time electric heaters are more expensive, and have proved economical only in such small articles as irons. In a few years electricity may be much cheaper, and then it may drive its older rival from the field. At the present time, however, gas for heating purposes is firmly entrenched, and there are many who prefer it as an illuminant to electricity, for the reason that it is not so hard on the eyes as the fierce white glare of the electric light.

AN UNUSUAL COMBINATION OF REINFORCED CONCRETE AND CONCRETE BLOCKS.

The E. E. Woodward Building at Rockford, Ill., is notable in that the construction is a combination of reinforced concrete and concrete blocks. The entire frame, including columns, floors and stairways, is of reinforced concrete, while the walls and partitions are constructed of concrete blocks. No wood is used except for window frames. It is interesting to note that the blocks carry none of the load of the building and contents except their own weight. The building is 143 by 70 feet, five stories high with basement. The concrete used was proportioned 1:2-½:4. The Simpson Construction Co., of Chicago, were the contractors for the concrete work, while the building was designed by Francis M. Barton of the same city.

APPLICANTS FOR PUBLIC APPOINTMENTS.

To anyone who has had occasion to advertise for applicants to fill a position the following comments by a borough surveyor, in a recent issue of The Surveyor, will be of interest. It would be well for all applicants for positions to note carefully the remarks.

Only a very few of those of us who enter the municipal or local government service can hope to progress very far in our career without undergoing the ordeal of becoming a candidate in open competition for a higher position.

Again, only those who have entered the arena time after time without success can appreciate fully the dreadful sense of discouragement that comes over one on receiving quite a number of polite little circulars informing us that Mr. So-and-So of somewhere else has been successful.

Of course, in the public service, of whatever branch, the stress of competition, as in every other walk of life, grows keener day by day, and disappointments must be expected, if only from a study of the numbers one sees from time to time as having applied for this or that post.

Still, one often wonders just why the successful candidate should have been selected in preference to oneself. He does not come from as good an office as our own, he is younger, and does not appear to have nearly as good qualifications. "Luck," perhaps; well, very often it is just that and nothing more, or at any rate that intangible factor has entered very largely into the result. And yet if you were behind the scenes you would very often see clearly the why and wherefore. For while it is true, no doubt, that such things as "local influence" and "personal canvassing" are still potent powers in the land, I think it must be conceded that in nine cases out of ten nothing more or less than first of all a smart application ensuring a place on the selected list, followed by a favorable impression at the personal interview before the committee or council, has brought about the result. It surely behoves us, then, to put our very best effort into our application, recognizing that nothing but this has the slightest chance among so many aspirants, and always remembering that from this short document alone those who have the selection have to form an estimate not only of our qualifications, but, from internal evidence contained therein, our personal character.

It has been my duty to open, analyze and tabulate the applications received on several occasions, and quite recently to prepare a select list for a junior appointment in my own office. On completing my task I stood contemplating the heaped-up pile of human effort, wondering if I really had selected the the best six, or whether lying buried amidst the number of unsuccessful applications was some undiscovered gem of sterling worth.

This would, with every care on my part, have been quite possible, from the fact that so many of the applications bore evidence of want of training and method in preparation, and thus it may be that a candidate having really good points had quite failed to bring them to my notice. Let it be recognized, more especially by younger members of the service, that an application, to stand out from its fellows, must be prepared with that object, and be such as immediately to command attention.

Everything counts, right from the very envelope in which the application is sent to the testimonials it encloses. Handwriting, good paper, legibility, the marshalling of facts in clear chronological order of training and experience, general style and appearance—all lend their weight.

The first point, perhaps, that I can recommend is a very careful study of the advertisement, and having made this, consideration if you are in every way eligible. It is of no use blinking facts to oneself. Competition is so severe that unless you are competent from training and experience, or, for example, are not within the limits of age, it is useless to waste your own and other people's time by applying. Do not think from this that I wish to damp anybody's laudable desire to get on, and, of course, "luck" might come your way. Really, though, there are already so many people who cumber up the candidates' list and who by no possible chance can hope to succeed, that they cause themselves a deal of unnecessary trouble, expense and disappointment. Do not imagine I mean that, supposing a borough surveyor has a vacancy for a qualified "General Assistant," you are eligible because you have just completed your articles with an architect in private practice, or that for a public library requiring a librarian you are just the man because you are in a town clerk's office. You have not had the specialized training required, and fifty of the others who apply will have. Take any hint, also, contained in the public announcement of the vacancy, such as "preference given to candidates holding the certificate of the Surveyors' Institution." If you have not this diploma, its equivalent or something better, do not apply. Modern practice all tends towards specialization in greater or less degree. No, choose your department, and get every qualification you can that it requires, then sail ahead when opportunity offers and "Try, try again." Quite 30 per cent. of the applications I referred to a little while since were received from persons having no possible qualifications for the post, and this is no solitary example.

Having decided, then, to become a candidate, let us return once more to the advertisement. Follow its directions implicitly down to the smallest detail. If it asks for everything to be in the candidate's handwriting, do not, for instance, type or print your copies of the testimonials. If it asks for two testimonials, do not send in three, or any like foolishness.

It would be impossible here to do more than indicate generally the lines your application should follow, as the circumstance will vary in some degree with the class of appointment offered. You will, however, have already gathered the care and attention I advise you to pay to many things. As I have already said, you must remember that it will not only be from the subject-matter of your application that you will be judged, but an opinion will be formed of your general character from the internal evidence it contains. For instance, a man who makes careless mistakes there will be likely to make them elsewhere. If you attempt to deceive by palpable exaggeration there you are not likely to be reliable in your everyday dealings in your new post. If you do not produce a neat and businesslike document now, with so much depending upon it for your own advancement, are you likely to exert yourself to turn out good work in your employer's interest? Make the very best of your own goods —that's what you must do to succeed. But, on the other hand, do not state anything that will not bear investigation should it come to the test.

Among other small matters, address your application direct to the persons having the power of appointment, as, for example: "To the Mayor, Aldermen and Councillors of the Kirkhampton Town Council," or "To the Chairman and Members of the Wallsend Urban District Council," "Gentlemen." Then go right to the point. Do not say, as nine out of every ten candidates will: "Having noticed your advertisement in this week's Local Government Gazette for a general assistant in your surveyor's office, I beg, etc." Never mind how you got to know there was a vacancy. Say: "I beg to offer myself as a candidate for the position now vacant of general assistant to your borough surveyor."

Then give your true age on your last birthday. Do not quibble in order to make yourself appear a little older by saying "I am in my twenty-sixth year." If it is the end of February now, of course you can, if you wish, say "I was twenty-six years of age on March 14th last."

Then particularize your present appointment and qualifications, and go on to show (guided, of course, by the nature of the appointment) how your education, your having served your articles of apprenticeship, your subsequent appointments, the examinations you have passed, and your experience generally fit you in every way for the position offered; and, if a junior, impress them with the fact that you will prove a real assistant to your new chief if appointed.

Of course I can do no more than indicate that there are ways, by using your brains a little, of helping you considerably so to frame your application as to meet exactly the requirements of the situation. For example, let us suppose that a bald advertisement appears stating that the council of some seaside resort requires a new borough surveyor. You have never been there, and do not know the town a bit. Well, make it your job to find out everything there is to know of the class of place it is, and what special matters (like waterworks, public baths, or other projects, just a little outside the usual run, perhaps) will be under your control. Or, again, make a special point of enquiring what new large works, if any, are contemplated in the near future, such as an extension of the sewage system, or a new sea-defence wall and parade. Having gleamed what you require, it is easy to emphasize in your application that part of your experience bearing on the points in question. Obviously, for instance, on the other hand, it is no use to indite long paragraphs setting forth your special knowledge of sewage farms if the sewage is discharged direct into the sea. Need I say more? The advertisement will often give you general information, but frequently it is easy to gather a little particular knowledge of the greatest service. Before leaving this part of our subject, just a word more to the juniors—and that is, "Do not exaggerate." I have before me an application for a junior appointment from a boy in a borough engineer's office—a veritable prodigy if all he states is true, for he claims to have a thorough knowledge of surveying and levelling in all its branches, is an experienced draughtsman, with special knowledge of architectural work, and sewage and drainage, road making, private street works, waterworks and tramways, and yet makes at least two mistakes in spelling. Believe me, the man who is going to look through through your application will not expect all these things of you before you are twenty-one. He is more likely to be content with a genuine statement that during your articles your chief has been carrying out works of the comprehensive nature set forth above; that you have got some satisfactory knowledge of office routine, can make an accurate survey, produce a neat drawing, have passed a preliminary examination, or can produce a certificate or two from the Science and Art Department of the Board of Education in building construction or the like. I declare it to be an absolute fact that out of six selected candidates for a junior appointment who appeared before a committee here, and all of whom had stated in their application that they were competent surveyors, only one could read an angle set up on a theodolite standing in the council chamber, and four of the six were not able to make any attempt at all. Be warned, therefore, and do not hope to deceive by claiming to be able to run while still "in arms," for you would only be miserably unhappy if by any chance you managed to secure the position and were found wanting.

And now as to testimonials. I am afraid at this date, while they are still the fashion, their value has been considerably discounted owing to experience common to us all. Let them at any rate have some bearing and be a little varied. By that I mean get them from people competent to form a judgment. To produce one from your schoolmaster when you are twenty-five has only a limited value. He cannot judge but generally of your professional ability. Suppose, for instance, three are required; get two that speak of your professional qualifications, and let one go to show something of your personal character.

Your application is now ready for dispatch, printed it may be, and neatly bound up in narrow green ribbon for an important post, typed or neatly written for others, but always with an outside title page setting forth tersely its contents. Send it off then in good time; do not wait until the very last day or post. There are such things as accidents; and do not forget to put the endorsement on the outside of the envelope.

On the much-debated question of convassing I shall say but little. In many instances this is now strictly forbidden, but in others "personal" canvassing only is tabooed, and it is still permissible to send a copy of your application and testimonials to the members of the local authority or committee. The names you can easily obtain, as a rule, on application, or from the local newspaper people. Do not forget that you must spare no legitimate effort to make your name stand out from the ruck in some way or other—even if it is only by using blue foolscap instead of white. As to any personal influence you may be able to bring to bear, I can only leave that to your own good sense and taste; but always remember that frequently more harm than good is done by the people who pester on behalf of candidates of whom they have no real personal knowledge whatever.

Now only remains the fateful interview. Our application has done the work required of it, and we have been requested to present ourselves as one of a selected number for inspection. Here, of course, a man's personality counts for a very great deal, and it is everything to create a good impression. I am afraid it is of little use to tell the nervous man, who positively dreads it, not to be afraid, but one can warn the very cocksure of going to the other extreme.

All things count, dress and general appearance, of course. Do not overdress, but, at any rate, go looking, as it were, worth your money. Perhaps, however, the one great tip is contained in the words "Speak up." There are sometimes quite a number on the committee or council, and there are certain to be some who cannot hear well; but anyhow it gives a general impression of confidence.

You must be on the alert for opportunities to bring out your strong points. Do not worry by anticipating that they are going to ask you too much or questions you may not be able to answer. They will not; for, as a matter of fact, unless the interview has been arranged beforehand by the chairman or head permanent official, you will be surprised at the somewhat inane things that will be asked of you, or find that you are being merely required to confirm a few points in your application. You will not often get a chance to say much to the point unless you are quick to make the opportunity for yourself as you go along. In conclusion, I wonder if I shall be understood if I tell you never to say "No" to anything.

Reading over the foregoing I very much doubt if I am competent to give you all the advice I should like to give. Certainly I myself have made very nearly all the errors I am asking you to avoid, but if I have succeeded in helping any of those who are coming after me to put up a little better show on the next occasion they enter the list my efforts will not have been entirely in vain.

CIVIC STREET ILLUMINATION.

The many and important changes brought about in the matter of street lighting are becoming noticeable throughout the streets and thoroughfares of nearly every Canadian municipality. The changes have not been so noticeable in the method of supply but in the means of light distribution and the method of fixture treatment along the streets.

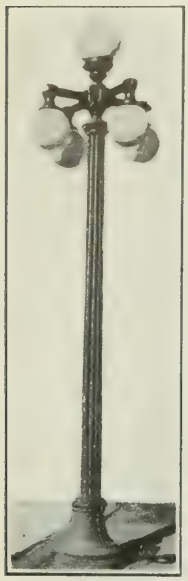


Fig. 1.

In the lower portion of the province of Ontario the policy of the Hydro-Electric Commission has been a potent factor in the furthering of new systems of street illuminations, but that this policy is not alone responsible for these changes is exemplified by the large number of municipalities who have discarded the arc flame system for the incandescent standards and still rely on steam driven dynamos for their current.

In many cases the design of the supporting columns has been carried out to an advanced state of perfection with the result that the appearance of the highway has been greatly improved and enhanced.

There are many advantages attending the use of these incandescent standards over the use of the arc lamp, and among these may be mentioned the even distribution of light, the reduced cost of maintenance, and the civic beautification.

Fig. 2.

The city of Toronto, Ont., lays claim to being among the first cities in Canada to entertain and carry out a progressive system of municipal street lighting.

In the execution of this work two types of lamp standard were employed; one consisting of an ornamental cast iron, circular base carrying five globes (four inverted and one upright); the other a reinforced concrete pole carrying one lamp in a cylindrical iron and glass support over the sidewalk. These latter standards are used on the residential streets and sections; the use of the former being confined to the heart of the business section.

As a general rule, the designers of these ornamental standards have allowed facilities for five globes; four being supported on cross arms and the fifth projecting from the end of the supporting column. Figure 1 gives an idea of the appearance of the large standards in the city of Toronto.

Aside from the necessity of careful planning and engineering there appears to be one important factor which must be considered before the system is a success, and that is, the nature and manufacture of the glass globes that surround the incandescent lamps. The Macbeth-Evans Glass Company, of Pittsburg, Pa., have made a study of this phase of the problem and have advanced the art to such an extent that they have received orders from many large and important municipal councils in this country. All the globes appearing in the illustrations accompanying this article were supplied by the above mentioned firm.

Figure 2 represents the appearance of a residential street in Toronto that was among the first to receive treatment from the Hydro-Electric Department. This street branches from the main thoroughfare and extends for a distance of about two long city blocks. As may be noticed from the posts in the foreground, two iron rings painted dead black support the ground glass globe and a metal crown on the top completes the make-up of the fixture.

The treatment of the down town sections is illustrated in Figure 3, which shows up under exceptional circumstances owing to the almost entire absence of other poles or posts. It will be noticed that the iron standards receive their operating current from wires buried underground, while the concrete standards are fed from top wires carried by the pole itself. In a few cases the iron fixtures attached to the con-

crete standards have been placed on tall wooden poles in certain sections of the city, but these poles are used to carry feed mains other than those used for supplying the lighting standards only.

The following table gives the more important specifications and figures of the lighting system of Toronto and Buffalo, N.Y. It affords a practical basis for cost estimation of similar equipment.

Fig. 3.

	Toronto, Ont.	Buffalo, N.Y.
No. of posts in installation	450	86
Typical street width	42′ 0″	60′ 0″
Post spacing	80′ to 100′	105′ to 125′ staggered
Height of post	10′ 8″ 13′ 0″	10′ 6″ 12′ 6″
Lamp arrangement	1 upright 4 pendent	1 upright 4 pendent
Size of lamps	5 100-watt	5 60-watt
Size of globes	(12″ x 6″) (14″ x 7″)	(12″ x 6″) (16″ x 8″)
Methods of wiring	5 Multiple lamps in series on 550V power circuit	Multiple
Kind of current	Alternating	Part direct and part alternating
Location of wiring	Underground	Underground
Time of burning	All lamps burn all night	All lamps burn all night

Some manufacturers of dairy machinery are now using monel metal for those parts subject to corrosion, experiments having shown the chemical resistance of this metal, and also its particular suitability for making pails, pans, ice cream freezers and the like.

MAINTENANCE OF THE DIESEL ENGINE.

The following notes published in a recent issue of The Electrical Review, of London, will be of interest to Canadian engineers, for a number of Diesel engines are now being installed in this country.

After two years' experience of this class of engine, the writer has no hesitation in saying that such engines are quite reliable for central-station work; any trouble experienced at first was entirely due to lack of experience on the part of those in charge.

Unless the valves, &c., are kept in practically perfect condition trouble will be experienced in starting, as the engine depends entirely on the compression for firing the charge; some engineers will consider this an advantage, but it is a serious matter for a supply station should an engine fail to start when the load is rushing on.

Where one engine only is installed, the question of the starting air is of great importance, and a small compressor, driven independently of the engine, is almost a necessity. Where there are more engines than one, it is not likely that all will be out of order at the same time, and the supply of air is practically assured.

The engine most likely to fail to start is the single-cylinder type, the multi-cylinder engine being almost certain to run on one cylinder unless allowed to get into a very bad state. Therefore, the question of the supply of air is not so serious in this case.

In a residential district the noise of the exhaust may be objected to; while it is by no means excessive, the persistent rap is objectionable, especially at night.

In a case with which the author is familiar this was overcome by taking the exhaust into a pit, 10 ft. by 6 ft. by 6 ft deep, which was available, the outlet being through the silencer supplied with the engine, and it is now almost im-

possible to tell when the engine is running. In addition to the reduction of noise the back pressure on the engine was considerably reduced.

The engine ran for some time without trouble, the first failure to start being due to the exhaust valve buckling slightly, making is impossible to get the compression high enough for ignition.

The exhaust valve casing worked loose several times, and when it was tightened down hard the casing itself buckled; each of these events meant failure to start and loss of air. In one case the air pressure was as low as 200 lb. in one starting receiver and 450 lb. in the reserve, while there was 650 lb. in the blast receiver; even with this low pressure it was possible to start up on pure paraffin.

This trouble was overcome by having the shoulder of the valve casing turned down a little from the top of the seating.

The exhaust valve soon gets pitted and scored, and it requires grinding in about every three months on an engine running six or seven hours per day. It is only a matter of a quarter of an hour to change this valve, a spare valve and casing being supplied with the engine and a split lever allowing this to be removed without disturbing the other valve gear.

The air valve has given very little trouble, although it requires occasional grinding in, and once was badly "gummed up" with imperfectly consumed fuel; the cause of this is mentioned later.

As regards the fuel valve, the makers appear to consider that it requires more attention than other parts, but during two years' working this valve has given no trouble. It has been regularly cleaned and rubbed in once or twice with knife powder when overhauling the engine.

The starting valve stuck open several times when starting up and completely emptied one of the air receivers. This was found to be due to an accumulation of moisture in the receiver being carried into this valve and causing the spindle to rust and stick in its casing. The trouble was overcome by giving careful attention to the draining of the interccoler while the engine is running, and regularly draining the air receivers each day.

The lubrication of the compressor gave some trouble at first, because of the high-pressure valves occasionally sticking and causing a shut-down owing to the falling of the blast pressure, and the air pipe from compressor to intercooler becoming blocked by carbonized oil; the makers recommended that the oil supply to the high-pressure piston should be discontinued altogether, except for a few minutes after starting up, and this was found quite sufficient for lubrication and completely overcame the trouble.

The lubrication of the engine has given no trouble except for the piston, which requires careful attention. In most vertical type engines the oil is pumped into an annular space round the cylinder and reaches the piston through some six very small holes in the cylinder liner; these appear to be very liable to get blocked up and as it is necessary to dismantle the whole of the valve gear and draw the piston, to enable an inspection to be made, they are liable to be overlooked.

The piston has run dry twice in the two years, although drawn every six months for inspection, and in each case two of the holes were found blocked up. Fortunately the driver noticed the trouble before any damage was done to the piston.

The fuel pump valves require careful attention, and particularly the suction valve as any leakage past this will prevent the engine developing full power. Failure to start has resulted more than once through the suction valve casing working loose on its seat; this was not an easy fault to locate the first time is occurred.

The cooling water must be carefully watched, and it is suggested that the circulating pump, driven from the engine, is not sufficient, but that a supply should be available to continue a flush of water through the engine for about fifteen minutes after shutting down. The reason advanced is that the heat of the piston and cylinder walls is sufficient to bake any sediment left by the water into a hard scale. This assumes that the water runs out of the engine when the pump is stopped.

A cracked cylinder cover was another unexpected trouble, and the writer believes that this has occurred on more than one engine of this type. The only reason which has been suggested for this is that the engine must have been seriously overloaded or that scale had formed in the water passages, and the latter point will be definitely settled by opening up the damaged cover.

The crack was so slight that some difficulty was found in locating the trouble. The engine failed to start and the usual examination was made, all valves were ground in and rocker lever clearances set. The engines started up sluggishly on pure paraffin and ran as usual, but refused to start on ordinary fuel oil.

Indicator diagrams were taken (the engine again being started on paraffin) and the compression was found to be very low. A careful examination revealed a tiny crack on the seating for the exhaust valve casing, extending through to the seating of the fuel valve casing. On one side of the crack the seating was slightly raised, preventing the exhaust valve casing from bedding properly.

During the few hours the engine was running on this low compression, the whole of the valves and cylinder head were gummed up with imperfectly burned oil.

It will generally be found that the engine will be somewhat sluggish in starting when anything is getting out of order, it is therefore a simple matter to get things right before a failure to start occurs. Naturally one must have practical experience of the peculiarities of Diesel engines to ensure their absolute reliability.

Th freedom from accumulation of carbonized material of valves, piston, and cylider, is remarkable, and very little trouble is experienced in cleaning up when overhauling. The maintainance cost is also low, and is chiefly confined to the pipes and valves dealing with the compressed air. The high pressures used cut the valves at a rather serious rate.

There has been no falling off in efficiency, and the ease with which the exact cost per unit can be ascertained each day is very different to the practically guesswork method of the smaller steam power stations.

More lubricating oil is required than with a steam engine only, but if the auxiliaries of the steam plant are included, there is little difference; it will be found better not to depend too much on oil filters, as they do not appear to separate out the carbon properly.

The writer cannot speak from experience of long nonstop runs, the longest coming under his personal observation being of 120-hours duration. There is no reason to doubt that very long runs are possible, the only limit being the length of time the exhaust valve would remain good enough to retain the high compression necessary.

No mention has been made of fuel costs, as these are so well known, and it is sufficient to say that the maker's guaranteed figures are still maintained under working conditions.

WATERPROOFING ENGINEERING STRUCTURES.*

By W. H. Finley.†

My attention was first directed to the necessity for some method of waterproofing engineering structures by the number of limstone masonry arches that were slowly but surely deteriorating, due to the infiltration of water. Investigation disclosed that very little had been attempted along this line, and no definite information could be obtained regarding methods or materials. The waterproofing of a masonry arch presents no very difficult features, and my earlier attempts in this direction met with a fair degree of success. However, since the extensive introduction of the elimination of grade crossings in cities by the elevation of railways, the problem of waterproofing has been greatly complicated by the necessity for making the subway bridges water tight.

This has caused very rapid development in both methods and materials for waterproofing, until now you can get all sorts of information as to how it should be done and what materials to employ, and yet the problem is far from being satisfactorily solved. Engineers have received some very rude shocks in this line of work, causing them, at times, to doubt whether it was possible to do a satisfactory job of waterproofing. The rapid expansion in this field has

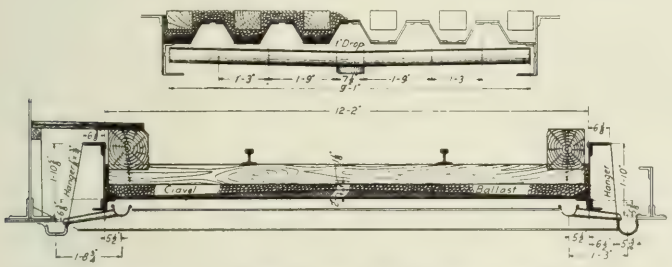


Fig 1—Section of Bridge Over Main Street Rockford, Ill.

brought into existence the waterproofing "expert," who takes his place along with the paint expert, who has for years periodically offered us a paint that would at last prevent the corrosion of metal structures; and yet the corrosion of metal structures still goes on.

While listening to the rival claims of advocates of different methods of waterproofing, the engineer must not lose sight of the fact that waterproofing, at best, is but an expedient, and will not take the place of proper designing, or correct poor construction. Water is a universal dissolvent, and if not gotten rid of in time will seep through the ordinary materials of construction. The first requisite in the designing of any structure that must be water tight is to provide means of getting rid of the water as directly and quickly as possible. In the numerous track elevation bridges around Chicago, whatever the type of construction, the usual practice has been to slope the floor from the centre to each end, carrying the water away back of the abutments, and right here is where much trouble has developed. Although one may place broken stone filling and tile drains back of the abutments, when the surface ice and snow melts in the springtime and the filling back of the abutments is still in a frozen condition, the water does not escape freely, but piles up and eventually seeps through at the end of the bridge and flows over the face of the abutment. In bridges having supports on curb lines and in the middle of the street, whether of flat slab construction or metal troughs filled with concrete, cracks are likely to appear where joints are not provided for over these supports, and where joints are provided for, trouble is likely to be experienced in preventing the seepage of water.

I will now take up, in a general way, the different methods and materials in use, and will first mention what is called the integral method. This method consists in adding a paste, powder, or lixivating water to the concrete, mixing it with the cement, the mass of concrete as a whole or with the water. While there is no doubt that any of these methods will make concrete impervious to water, as indeed can be done with ordinary concrete by careful proportioning and selection of aggregates, with subsequent care in placing, yet we know that monolithic concrete is apt to develop cracks from a variety of causes, and when that occurs you are likely to have seepage of water through the mass. For that reason I have always preferred for waterproofing engineering structures what has come to be called the membrane method.

When I first took up the question of a suitable material for waterproofing engineering structures, I investigated the respective merits of asphalt and coal tar pitch. The only instance of the use of the latter with which I was familiar had not proved very satisfactory, and I decided to use asphalt. At that time there were very few, if any, artificial asphalts on the market, and I necessarily used a natural asphalt. The structures then waterproofed are still in good condition. Since that time there has been an extensive development of artificial asphalts from petroleum oils. In nearly all cases it is claimed that the artificial asphalts offered for waterproofing purposes have a Gilsonite base. Gilsonite is described by G. H. Eldridge in his article on "The Asphalt and Bituminous Rock Deposit of the United States," as "a black, tarry-looking substance of most brilliant lustre, normally of absolutely homogeneous texture and exceedingly brittle." It is found in the Minta basin, Utah, and takes its trade name from S. H. Gilson, an early prospector. It occurs in vertical veins in enclosing sandstone, and the veins vary from a knife edge to 30 in. in thickness. It is generally conceded that the origin of Gilsonite and other hydrocarbons may be traced to petroleum. Inasmuch as the sandstone in which Gilsonite occurs contains no trace of petroleum, it is evident that it was forced up from a great depth by an enormous pressure. Gilsonite is a very pure form of hydrocarbon, and is used in a variety of ways in the arts and trades. It is used in varnishes and baking Japans, insulating materials in electrical work, and for making mineral rubber, as well as in the artificial asphalts. Taking the amount of waterproofing asphalts that are turned out every year I was interested in learning the total production of Gilsonite. I found from a reliable source that the total production last year was in the neighborhood of 30,000 tons, and the previous year somewhat less. I am afraid that the Gilsonite base of our artificial waterproofing asphalt is a very thin one. Petroleum oil is not a uniform product, varying very much at different places, and for that reason I have always been fearful that in asphalts made from petroleum oil we would not get a uniform product. However, I have had tested a number of artificial asphalts and found them to fill the following specifications very easily.

Material.—1. (a) Asphalt shall be used which is of the best grade, free from coal tar or any of its products, and which will not volatilize more than ½ of 1 per cent. under a temperature of 325 deg. F. for seven hours. (b) It must not be affected by a 20 per cent. solution of ammonia, a 25 per cent solution of sulphuric acid, and a 35 per cent. solu-

*Abstract of a paper before the Western Society of Engineers, March 18, 1912.

†Assistant Chief Engineer, Chicago & North-Western.

tion of muriatic acid, nor by a saturated solution of sodium chloride. It should show no hydrolytic decomposition when subject, for a period of ten hours, to hourly immersions in water with alternate rapid drying by warm air currents.

Range of Temperature.—2. (a) For metallic structures, exposed to the direct rays of the sun, the asphalt must not flow under 212 deg. F., nor become brittle at 0 deg. F. when spread thin on glass. (b) For structures underground, such as masonry arches, abutments, retaining walls, foundation walls of buildings, subways, etc., a flow point of 185 deg. F., and a brittle point of 0 deg F. will be required. (c) A mastic made from either grade of asphalt by mixing it with sand in the proportion of one of asphalt to four of sand, must not perceptibly indent, when at a temperature of 130 deg. F. under a load of 20 lbs. per sq. in. It must also remain pliable at a temperature of 0 deg. F.

In asphalting a metal surface it is imperative that the metal be cleaned of all rust, loose scale and dirt, and if previously coated with oil this must be burned off with benzine or by other suitable means. The metal surface must be warm to enable the asphalt to adhere to it, and the warming is best accomplished by covering it with heated sand, which should be swept back as the hot asphalt is applied. When waterproofing concrete structures it is very necessary that the surface be thoroughly brushed with wire brushes to remove all loose particles and get rid, as far as possible, of what the French call "laitance." It should then be coated with a liquid asphalt primer, and I believe that better results will be obtained if, just ahead of the application of this primer coat, the surface is swabbed with gasolene.

I am not an advocate of felts or burlaps for ordinary waterproofing. I believe that any ordinary concrete surface, whether in a slab bridge or an arch, needs nothing but an application of a primer coat of asphalt and then a coat of liquid asphalt, after which a hot sand mastic, composed of one part of asphalt to four of sand, can be applied with hot smoothing irons. On top of this it has been my practice to put on a swabbing coat of hot asphalt and then to cover the whole surface with washed gravel, particularly where rock ballast was to be used. Over joints and ends of bridges it may be necessary to use burlaps for the added strength they give the asphalt in taking care of any slight movement. However, in cases of expansion joints, where any defined amount of movement is to take place, I believe that special means, such as copper flash joints, should be used. Burlap is a vegetable fibre and if used should be thoroughly saturated in a bath of hot asphalt of such temperature that it will not char or destroy the fibre. To apply asphalt to raw burlap in the field I think is wrong. If the asphalt is hot enough to penetrate the fibre it is likely to be so hot that it will char or destroy it, and if the asphalt is not hot enough one gets only a surface coat.

I would like to repeat what I have previously said about the necessity for so designing your structure that the water can be disposed of as directly as possible. If more care were taken in designing, elaborate or expensive forms of waterproofing would be unnecessary.

Asphalt has no affinity for water, and all surfaces that are to be coated with asphalt should be as dry and clean as possible.

The methods I have used in preparing the asphalts are as follows:

The asphalt should be heated in a suitable kettle to a temperature not exceeding 450 deg. F. If this is exceeded it may result in "pitching" the asphalt. Before the "pitching" point is reached the vapor from the kettle is of a bluish tinge which changes to a yellowish tinge after the danger point is passed. If this occurs the material should be tempered by the addition of fresh asphalt. The asphalt has been cooked sufficiently when a piece of wood can be put in and withdrawn without the asphalt clinging to it. Care should always be taken not to prolong the heat to such an extent as to pitch the asphalt. Should it become necessary to hold the kettle for any length of time, bank or draw the fire, and introduce into the kettle a quantity of fresh asphalt to reduce the temperature.

There is a wide difference between the requiremnts for damp proofing waterproofing to take care of ordinary rainy weather and waterproofing where it is necessary to take care of the hydrostatic pressure of a head of water. In the latter case felt, and burlap mat properly reinforced with concrete, will be necessary.

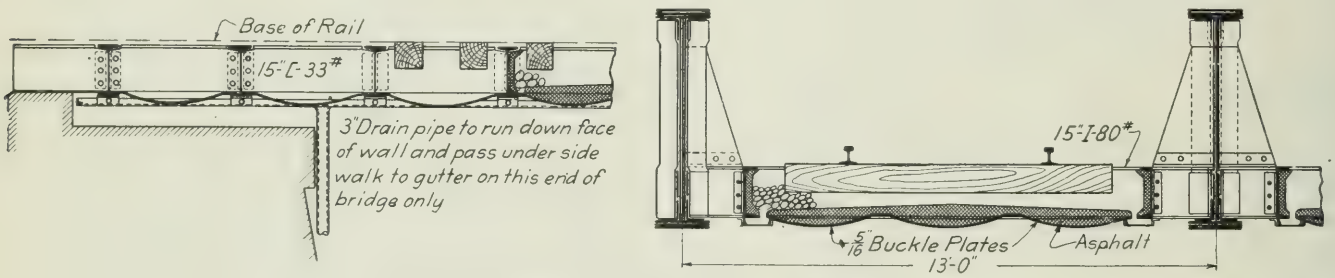

Base of Rail
15"I-33#
3" Drain pipe to run down face of wall and pass under side walk to gutter on this end of bridge only
15"I-80#
5/16 Buckle Plates
Asphalt
13'-0"

Fig. 2—Shallow Ballasted Floor Bridge in Highland Park, Ill.

One of the early applications of waterproofing was made on a stone arch bridge over Turtle Creek near Shopiere, Wis., on the Chicago North Western. This bridge consists of five 50-ft. arches, and was built in 1869 of Joliet and local limestones. The seepage of water through the ring and parapet walls reached such a stage that it seriously threatened the life of the structure. In 1887 this arch was uncovered and the top thoroughly waterproofed with California asphalt. Three years ago I removed the filling and took up some of this natural asphalt, finding it in first-class condition. The waterproofing of this arch at this time prevented any further leakage, and unquestionably prolonged the life of the structure. I have waterproofed a number of old stone arches that were showing signs of disintegration due to the lack of drainage. In 1896 a couple of 30 ft. arches over streets in the town of Janesville, Wis., were in such condition that it was a question whether they should be rebuilt or not. These arches had been built in 1864 of limestone with lime mortar. Inasmuch as the double tracking of this portion of the road some time in the near future was completed, it was desirable to carry these arches as long as possible. They were uncovered and thoroughly waterproofed with asphalt. This prevented any further deterioration from the seepage of water, and in 1906, over ten years after the waterproofing was applied, these arches were replaced by double track concrete arches. The asphalt was found to be in excellent condition and a part of it was used in waterproofing the new arches.

Fig. 1 is a view of a three-track bridge over Main Street, Rockford, Ill. This bridge was built in 1893, and waterproofed with California natural asphalt. During the 18 years it has been in place there has been no complaint regarding the dripping of water or leakage from the bridge, although it is over the principal street in Rockford. I attribute this largely to the fact that the water is drained from each floor trough into drainage troughs and carried by pipes through the abutment and outside of the dump. This is one instance of getting rid of water as directly and as quickly as possible. It avoids the trouble that is usually experienced at the end of the bridge where the drainage is carried from the centre to each end. The only trouble experienced with these troughs is from birds building their nests in the same during extended dry spells. These troughs have been renewed once since they were first installed. In later work troughs for a similar purpose were made of a much heavier material. The locomotive stands on this bridge while discharging and taking on passengers at the Rockford station, and I have seen locomotives with their waste water cocks open pouring large quantities of water on this floor, which was carried off directly and without any trouble.

Figure 2 shows a very shallow ballasted floor bridge over Vine Avenue, Highland Park, Ill. It was necessary to provide a water tight floor at this point, and this type of floor was adopted. It has troughs, and instead of carrying any of the water back of the abutments it is actually carried down in front of the abutment through troughs and down spouts. These troughs can be so arranged that it would be impossible for any trouble to occur from birds building their nests and stopping the troughs. This bridge was built in 1902.

Figure 3 is a view of a subway on what is called the Kinzie street track elevation, Chicago. You will note in this case the water is carried from the centre of the subway to each end. A somewhat different method than I usually employ was used in waterproofing this bridge. The asphalt is imported mastic fluxed with Trinidad and Bermuda, and the asphalt mastic is covered by a layer of reinforced concrete. This work was done in 1905, and has proved very satisfactory, with the exception that there is some seepage of water at the ends of the bridge over the abutments. The method employed in sealing for the end, as shown in this view, did not seem to be completely satisfactory.

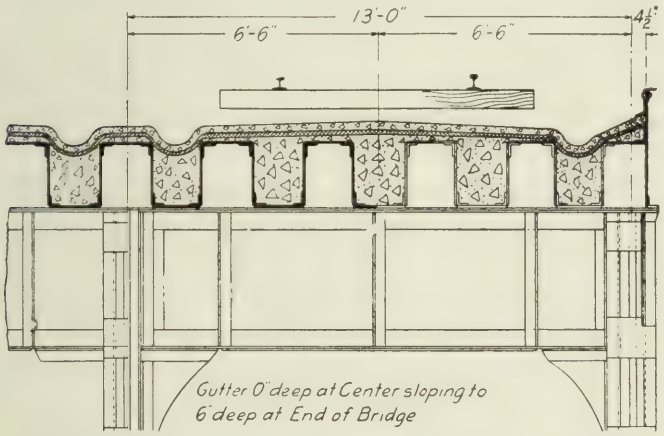


Fig. 3—Section of Subway Over Kinzie Street, Chicago.

Figure 4 shows a proposed treatment of the ends of city subways to prevent the possibility of water getting through and flowing down the face of the abutment. This is an attempt to seal it off completely by the use of a burlap mat instead of the usual bent plate method that we have previously used.

The bridge over Wauwautosa Avenue in the town of West Allis, Wis., is similar in construction to the Vine Avenue structure. Last fall it was necessary to remove this bridge to make way for improvements at that point, and I was very much gratified to see how thoroughly the iron had been protected by the asphalt mastic. A bridge of this type with such a shallow floor is subject to more or less vibration and deflection that would, under ordinary conditions,

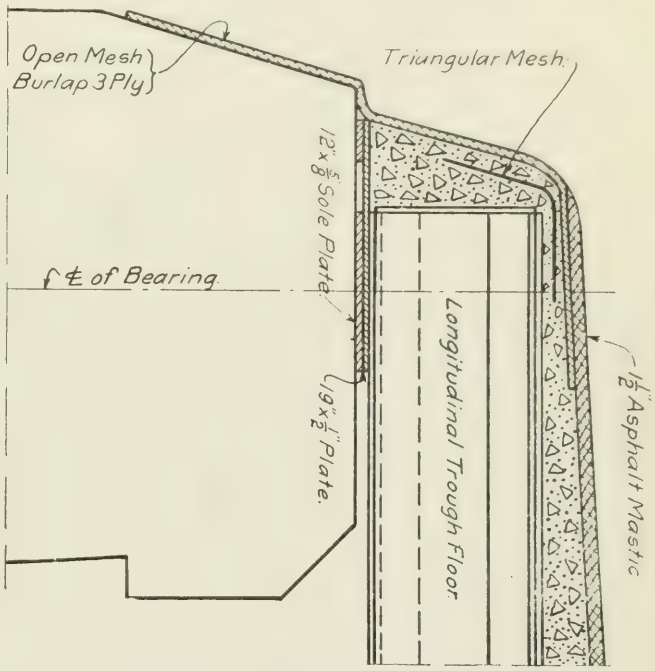


Fig. 4—Proposed Treatment of the Ends of Subways.

make it very difficult to waterproof. However, in this case, when the bridge was taken apart and the asphalt removed there was no indication of any rust or seepage of water through or under the asphalt.

CEMENT SEWER PIPE.*

By Gustave Kaufman, C.E.

The matter brought out in this paper is based upon the experience gained from the use of concrete sewer pipe in Brooklyn. As is generally known, about 400 miles of such pipe, below 24" in diameter, have been laid and is in use there. It can be truly said that this pipe has given eminent satisfaction to the authorities and has been maintained at a lower cost, per mile, than vitrified clay pipe of the highest grade.

Before starting upon the real subject of this paper a description of this pipe and method of its manufacture, is here given.

Pipe are made in 6-inch, 9-inch, 12-inch, 15-inch, 18-inch and 24-inch equivalent capacity. The 6-inch and 9-inch are plain round pipe; they are all three feet in length, with hub joint, with the exception of the 6-inch which is two and one-quarter feet. The 12-inch pipe is round with flat base, and the 15-inch, 18-inch and 24-inch pipe are egg-shaped, with flat base. The thickness of the walls are as follows:—

*Presented at the Eighth Annual Convention of the National Association of Cement Users, Philadelphia, Pa.

6-inch	3/4"
9-inch	7/8"
12-inch	1 1/16"
15-inch	1 3/8"
18-inch	1 5/8"
24-inch	2"

The collars are as follows:—

6"	collars—1 5/16"	in	depth	with joint of	1/8"
9"	" 1 5/16"	"	"	"	1/8"
12"	" 1 5/8"	"	"	"	3/16"
15"	" 1 5/8"	"	"	"	1/8"
18"	" 1 5/8"	"	"	"	3/16"
24"	" 1 3/4"	"	"	"	1/4"

These cement pipe up to 1890 were made by hand, when pipe made by machines were introduced by the Wilson & Baillis Manufacturing Company. With the hand-made pipe it was always difficult to thoroughly mix the ingredients of the concrete unless the workmen were closely watched and frequently resulted in a pipe far from homogeneous and of equal density throughout. In the manufacture of the machine-made pipe the cement, sand and trap rock are measured and thoroughly mixed in the machine mixer, evenly fed to the molds, and rammed by machinery with iron rammers regulated to produce continuous and uniform blows of any impact desired. The result is a product perfectly homogeneous and of equal and great density throughout.

The machine used for manufacturing the pipe consists of a mechanical tamper and a revolving table upon which the molds are placed. The tampers have a vertical reciprocating motion and at the same time move outward and inward rapidly so as to conform to the line of the travel of the mold which owing to its oval form, presents, at each revolution, varying diameters to the successive tamping bars. There are eight tampers made of the best tool steel, running two hundred tamps a minute each. Only one rammer is down at a time. The head, which consists of the actuating machinery for the tampers, is counter-balanced upwards as the mold is being filled with concrete. The head is raised by the density of the concrete and in this way an even and regular product is obtained which is impossible to achieve by hand. The force of the blow of each rammer is about one inch square.

The proportions, which have been used in later years, are one and one-half parts of the best grade of Portland cement, one part of sand and three parts of trap rock screenings, containing twenty per cent. of stone dust. The percentage of water used to the whole bulk varies from ten per cent. to fifteen per cent., according to the condition of the ballast. The mix when dumped on the floor is apparently dry, but will ball in the hand with some pressure. An extra mix is used in forming the collar for the reason that as the rammers do not exert a direct blow on the material in the offset compression of the material must be depended upon.

The mixed concrete is delivered to the machines in barrows and it is fed into the hoppers by two men, one on either side. As soon as the flask is full, and the core automatically lifted clear, the flask is taken up by a pipe truck and wheeled into the stripping rooms where it is allowed to stand usually thirty minutes when it is stripped. After the pipe have set over night a spray of water is turned on and the pipe kept damp until at the expiration of six days they are removed from under cover and placed in the yard. The pipe, at the expiration of thirty days, are set sufficiently to be handled in the work.

Spurs for house connections are connected on the pipe. A hole is cut at the proper point on the side of the pipe and a mold is placed in the interior. Cement mortar is then spread over the mold and the connection piece is bedded in place and a heavy band of mortar is wiped around the joint on the outside. After the mortar is removed the inside joint is finished with a trowel. This method has been found to be entirely satisfactory.

The main advantages of cement or concrete pipe over vitrified clay pipe, are:—

First—They can be constructed so as to give them an oval or egg shape.

Second—They can be made with practically no variation in size.

Third—They can be constructed with a flat broad and level base.

Fourth—The joints can be made so that the pipe are self-centring, and so that the joints will fit so closely that a continuous smooth bore can be obtained.

Fifth—They can be made in many localities where the cost of vitrified pipe is prohibitive.

Oval or egg-shaped pipe are very desirable where the flow of sewerage is variable and where the gradient is very slight. The small invert will permit the flow of small quantities of sewerage with minimum friction on account of the wetted perimeter being less than in the circular pipe.

Pipe of such shape are thoroughly self-securing whenever there is an increase in the flow of the sewerage and besides will effect a decided saving in flushing water. Pipe of this shape cannot be made of vitrified clay due to the wrapping in burning.

In the transactions of the American Society of Civil Engineers, June, 1911, Mr. Geo. T. Hammond, of Brooklyn, while discussing the paper on Monterry Water Works and Sewerage, strongly advocated the use of the egg-shaped pipe, even as small as 8" in diameter. In the Monterry system, eight-inch vitrified pipe was used, but its capacity was much greater than necessary at present. Mr. Hammond says:—

"The writer's experience with concrete pipe derived mainly from a long service in sewer design and construction in Brooklyn, N.Y., leads him to believe that at Monterry the whole system might, with advantage, have been built with concrete pipe, using an egg-shaped pipe with an area slightly larger than an 8-in. circle designed for a discharge equal to an 8-in. pipe for all the smaller sewers. The invert of such an egg-shaped pipe would fulfill the present requirements in carrying a very small flow with good flotation depth, better than would a 6-in. circular pipe, and the reserved capacity of the 8-in. pipe would be secured without interfering with good present service. Egg-shaped pipes, similar to those used in Brooklyn, the writer believes, would have given far better satisfaction throughout the Monterry sewerage system than circular fire-clay pipe, and would have cost no more, but probably less. The egg-shaped pipe referred to is made with a flat base and a self-centering joint, thus insuring perfect alignment, and a smoother interior surface than can be obtained with fire-clay pipes."

Cement pipe, in curing, retain accurately the shape given them by the molds. Vitrified clay pipe pipe, especially in sizes from 15" and up, are considerably warped, due to the burning.

In Brooklyn and many parts of Europe concrete sewer pipes are molded with a flat level base. Such a base permits the pipe to rest on a flat foundation, either earth or plank, and thus permits of better back filling. Improper back filling is the cause of much breakage in circular pipe, not supplied with a flat base.

The joints of cement pipe should be so designed that the hub and socket will accurately centre themselves. This can be done in cement pipe by making the socket with slightly flaring ends thus causing the hub, when driven home, to cone to its proper position. The vitrified pipe, on account of the warping in burning, must have wide sockets. Such wide sockets are the cause of the offsetting at each joint wherever they are laid. These jogs, or off-sets, collect solid matter in a sewer, and, of course, retard the flow very much. When small openings are used, such as can be made with cement pipe, this difficulty is entirely eliminated and a close and smooth joint is the result. In many places no cement at all is required in the joint as the slit in the sewage quickly fills up the small opening.

In many sections of the country vitrified pipe can only be shipped at great expense, and, wherever under such conditions, concrete materials can be obtained, it is far cheaper to make sewer pipe of cement. In many places of Europe, where there are no clay deposits, concrete sewer pipe has been used for years without any question whatever as to its suitability for sewer purposes.

Durability.—In 1877, when Julius W. Adams, Past-President of the Am. Soc. of C. E., was chief engineer of the city of Brooklyn, there was a proposal made that the use of earthenware pipe should be resumed. This proposal was adversely reported upon by Mr. Adams. The following are some quotations from his report:—

"Last winter there were careful inspections made of our pipe sewers. In one sub-division the grades of streets are over two-and-a-half feet to the one hundred, and a special examination was made of the pipe in this sub-division. There is no sign of disintegration or wearing away of the cement pipe. These pipe have been laid over five years. On the 25th of March, 1873, this department took up a cement pipe that had been laid in Fleet Street in the year 1861, and the pipe was found, in every particular, as good as when laid." . . . "The fact remains, however, that the renewals of sewer pipe in Brooklyn, on account of breakage or collapse, have been relatively less in the case of concrete than in that of earthenware pipe."

Since the above was written many more miles of cement pipe have been laid, and, as stated earlier in this paper, over 400 miles of cement pipe are in use in Brooklyn. The experience of Mr. Adams has been confirmed since that time. The cost of maintaining concrete sewer pipe has been proven to be less than that of vitrified pipe. This includes renewals, due to breakage, action of acids, and so on. It might be of interest to note that a few years ago, during the construction of the subway in Fulton Street, Brooklyn, more of the Fleet Street sewer pipe, referred to by Mr. Adams, was taken up and was found that it would be still good for a long time. The sewer was then about 50 years old. A few lengths of this pipe are in our possession. It is manufactured of natural cement, Cow Bay sand and gravel.

The main argument against the use of concrete pipe is that it cannot withstand the effect of sewerage, nor resist the action of acids. In Brooklyn but two cases have been called to our attention where there has been a failure of cement pipe, due to concentrated acids being admitted in the sewers. Inasmuch as such sewers have been existence for so many years, the percentage destroyed is entirely neglegible. The author desires, at this point, to make the statement, as an engineer, that if it is desirable to install a sewer which is to take concentrated acid discharges from manufacturing concerns, he would not advocate the use of cement pipe; but would suggest, for such conditions, vitrified pipe of the best quality, with joints of some asphaltic or acid resisting nature and that manholes be built of some other material than brick, laid in cement, because strong acids effect only cement, not bricks. It seems to be folly to dwell upon such a contingency. No manufacturer is going to be so extravagant as to permit highly concentrated acids to be wasted. They are too valuable.

Mr. Adams, in his report of 1877, says:—

"There has been considerable written about the acids acting injuriously upon cement pipe, but these acids in sewerage matter are greatly diluted, and I am convinced by the experience in this city that they will seldom destroy a good cement pipe. We have known of no case in this city where the street sewer has been disintegrated or eaten away by sewer acids or gases."

Mr. A. J. Provost in "Municipal Journal and Engineer," vol 20, page 388, says:—

"The argument advanced against concrete sewers is still confined to possible disintegration by acids. The fact remains, however, that the renewals of sewer pipe in Brooklyn on account of breakage or collapse have been relatively less in the case of concrete than in that of earthenware pipe."

Mr. Rudolph Hering, consulting engineer, in a report dated February 15th, 1908, to Honorable Bird S. Coler, President of the Borough of Brooklyn, says.—

"Portland cement used for the manufacture of concrete pipes is attached by certain strong acids, such as sulphuric acid, which converts the carbonate into sulphate of lime, otherwise called gypsum, which is comparatively soft and easily corroded. Therefore, cement pipe cannot be used where strong acids are known to enter the sewers.

"Vitrified pipe will stand the effect of most acids. When the joints are made of cement these will, of course, be acted upon by acids as readily as the cement pipes.

"It should be added that the acid question should be viewed in a reasonable light. When the dilution of sewage is sufficient the discharge of a small amount of even the strong acid will not cause objectional effects as evidenced by European cities where the use of concrete sewers is almost exclusive in some cities, as Paris and Vienna. In England concrete sewers are also very common. Strong acids attack not only cement, but brick. Yet bricks are extensively used both in America and in Europe for building large sewers, where naturally any acid would be very dilute.

"The greasy substance which is usually found to coat the perimeter of a sewer under the water-line tends to protect the cement from the action of acids to some extent.

"It should be added that just as it is objectionable to discharge exhaust steam into sewers and the waste from gas works, which many cities prohibit, so it should be prohibited to discharge strong acid waste into the same."

The Joint Committee on Concrete and Reinforced Concrete of the American Society of Civil Engineers, American Society for Testing Materials, American Railroad Engineering and Maintenance of Way Association, and the Asociation of American Portland Cement Manufacturers, in its report presented at the annual meeting of the American Society of Civil Engineers, January 20, 1909, says:—

"Concrete of first-class quality, thoroughly hardened, is affected appreciably only by strong acids which seriously injure other materials. A substance like manure, because of the acid in its composition, is injurious to green concrete, but after the concrete has thoroughly hardened, it satisfactorily resists such action."

Much more could be written about the advantages and durability of cement pipe, but it would be largely reiterating what has been already written about it by others and

enumerating the many places both in Europe and America where cement pipe has been in use for many years.

The author has positive knowledge that over 400 miles of such pipe laid during a period of over 50 years are giving eminent satisfaction in Brooklyn and in his opinion all arguments against its suitability for sewers are answered by that fact.

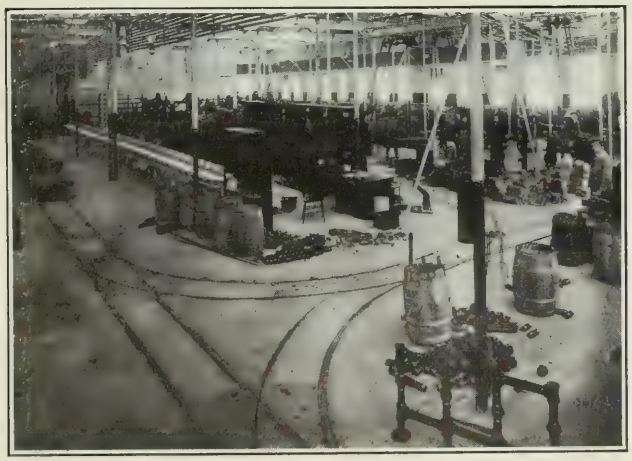
NARROW GAUGE RAILWAY INSTALLATIONS.

Narrow gauge railway systems are applicable to every industry and service where the reliable movement of material is essential and where large initial loads are moved irregularly and intermittently.

Such a system, as a production factor, can and should be judged in much the same manner as the productive tools and machines; that is, by balancing the time and labor saving, general convenience and efficiency increase on other tools against maintenance expense and interest on original investment.

The economies obtainable are best evidenced by use and continued extension of such systems in many power plants, foundries, machine shops, paper mills, textile mills, fertilizer works, chemical works, quarries, steel mills, gas works, powder mills, railroad yards, smelters, mines, coaling stations, brick works, wood shops, warehouses, etc.

A shop railway system without provision for power on the cars can be profitably applied almost wherever the movement of material, either finished or raw, or both, is done by hand truck or wheelbarrows, and averages three or more tons per day. One man, for instance, with a shop car, should easily be able to move on level track, a one-ton load that could not be handled in the same time with wheelbarrows by five men. With cars operated electrically from storage batteries, trolley or third rail, the loads that can be carried are limited only by the strength of the cars and track.

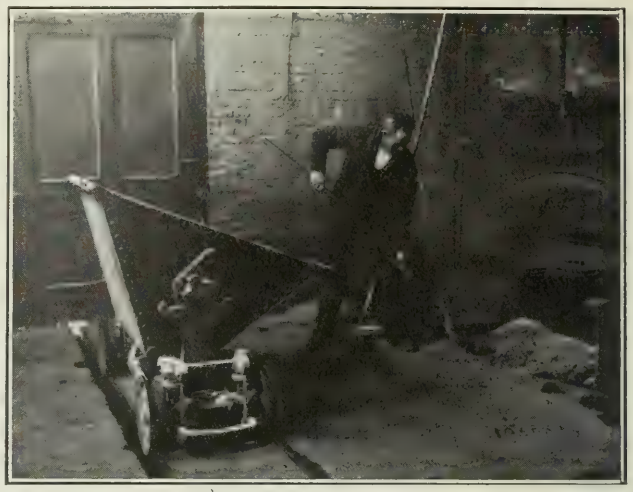


System Using Flat Top Cars in Machine Shop and Shipping Department. Utica Drop Forge and Tool Co., Utica, N.Y.

The loads on cars can generally be apportioned according to requirements up to a maximum car load of about 10 tons, a load distribution of one to three tons per car, under average conditions being very effective.

A railway system involves no expense when not in use, and is immediately available for peak loads. The car platforms can be adapted in size and height to best suit the carrying conditions as well as for ease of loading and unloading. Where desirable, the material may be kept on the car during manufacturing processes, the car being used as a platform and thus saving the labor of rehandling. Accurate weight of material while on the cars is easily obtainable by putting platform scales at any convenient point in the track system.

That a system of cars and tracks can be a profitable investment, is easily computed for any given conditions. As a rule, the labor saving alone justifies the installation.



Tip Car for Handling Ashes, Etc., Stevens and Thompson, Hoosick Falls, N.Y.

Suppose, for instance, the railway in a factory saved the wages of a boy at seventy-five cents a day. This saving of $225.00 per year alone would pay fifteen per cent. interest on an investment of $1,500.00. It would be hard to imagine a place where so large an expenditure could be made for a system of cars and tracks without effecting much greater net savings.

It is not uncommon for a shop railway system to save its entire first cost during the first year of its operation, and it would be a most unusual case where the direct saving each year would not equal one-third of the entire cost of the installation.

Not only is a direct saving of labor accomplished, but the facilitated manufacturing operations do much toward hastening deliveries, and frequently a more economical shop lay-out is made possible.

A narrow gauge railway system can be laid out by the shop manager, superintendent or anyone familiar with the points to be reached. There is seldom any part of a plant or building to which the tracks cannot be extended, and if the system is properly laid out there should be no inconvenience in getting the cars from any one point to any other on the lines. The track can usually be laid on any form of floor or road bed, and can be run across or between standard gauge railway tracks without cutting the rail heads. Any requirement of easily crossing rails with hand trucks or other vehicles can be met by filling in around or inside the tracks with concrete, boards, etc.

The illustrations show a few practical applications to various industries based upon the Hunt Industrial System, the parts of which are manufactured by the G. W. Hunt Company, West New Brighton, N.Y. In this system, the standard gauge of track is 21½ inches measured from outside to outside of rail heads and loaded cars of standard width require a passage of four feet clearance. Track and cars of other gauge are, of course, usable, as the conditions

may demand. The track sections, switches, frogs, cross-overs, etc., are made up on the interchangeable sectional unit plan, much the same as are modern filing cabinets. Any workman of ordinary intelligence can put the sections together and get the whole system ready for use. Should the movement of material change or extensions be required, this unit system of construction lends itself in a most flexible way to such changes or additions. Equipment of cars can also be made standard and interchangeable, which effects great convenience and economy.

A valuable feature of the Hunt System is the employment of a flexible running gear and outside flanged wheels on the cars and a special construction on the outer rail of curves, by means of which, as claimed by the manufacturers, a loaded car runs around a curve of as small a radius as 18 feet, as safely and requiring as little power as on straight-way. It is evident that with such flexibility of the system, the cars of a narrow gauge railway can reach any point that could be reached by trucks and wheelbarrows, including the movement of cars to different floors by elevators.

THE CHEMIST AS AN AID TO EFFICIENCY.

The industrial chemist points the way to great increases in efficiency, particularly in the item of buying supplies, according to Mr. Arthur D. Little, president of the American Chemical Society. In a paper on "The Chemist in Manufacturing," he says:

Chemistry points out the only proper way to buy supplies, which is on the basis of their industrial efficiency by means of specifications defining the quality desired and rigid tests to make sure that quality is secured. Independent estimates by those in exceptional positions to know place the efficiency value of supplies as purchased and used by American manufacturers at 60 per cent. of what it should be. .. ..

Similarly the industrial chemist has a large control over the efficiency of labor. He may increase this efficiency, that is, the output of the individual laborer, by supplying more efficient processes, as Bessemer did in case of steel, Tennant in case of bleaching, or Le Blanc and Solvay in the manufacturing of alkali. He may raise the efficiency of the laborer through education, as when firemen are instructed in proper firing methods or when cooks in the sulphite pulp mill are given boiling schedules; in one instance within our knowledge such schedules raised the efficiency, not of the cooks alone, but of the entire plant as well, over 50 per cent.

Nowhere has the industrial chemist greater scope for the effective exercise of his trained and organized common sense than in the control of processes and the elimination of wastes, and nowhere are the results he has already obtained more valuable. Their influence upon productive industry has been dramatic and profound. One need only point out that the whole art of modern steel-making is under the strictest chemical control, and quote Carnegie to the effect that it has been revolutionized thereby. No industry affords a better example of the value of such control or furnishes more striking instances of the profitable utilization of wastes. The conversion of slag to cement and fertilizer, the development of 10,000 horse power from the waste gases of a single furnace, are but steps in the development which will soon make pig iron the by-product of the furnace which derives its chief revenue from the waste of yesterday. With the open-hearth furnace still utilizing less than 10 per cent. of the energy of its fuel, let no chemist think the door of opportunity has closed.

WATER-POWER BRANCH.

The Canadian Engineer learns of a recent change in the organization of the Department of the Interior at Ottawa, of particular interest to engineers—the creation of a water power branch and the appointment of Mr. J. B. Challies as superintendent. The new branch is charged with the responsibility of all matters connected with the administration of water powers in Manitoba, Saskatchewan and Alberta, and also of all matters relating to irrigation, reclamation and power in the railway belt of British Columbia. In addition to a head office organization at Ottawa, the new branch comprises an extensive corps of experienced field engineers, having headquarters at Winnipeg, Man.; Calgary, Alta., and Kamloops, B.C., engaged in reporting on water power projects and the investigation of the water resources of the west, with particular reference to power. These investigations are being carried on under the advice of prominent consulting engineers, and when completed will be furnished the profession in the form of blue books. *The Canadian Engineer* hopes to publish a full account of these investigations in subsequent issues.

The superintendent of this work is a graduate of the School of Practical Science, class 1903, and an associate member of the Canadian Society of Civil Engineers. Mr. Challies' many friends will be glad to learn of his selection for this important work.

PERSONALS.

MR. JOHN W. EBER has been appointed superintendent of the Toronto, Hamilton and Buffalo Railway in succession to Mr. H. H. Adams.

MR. A. S. ANDERSON has been awarded the Boiler and Inspection Co. scholarship for general proficiency in the Department of Mechanical Engineering of the University of Toronto Faculty of Applied Science.

DR. J. W. S. McCULLOUGH, chief health officer for the province of Ontario, will be the provincial representative at the International Congress on Hygiene and Dermography, which meets at Washington during the late summer.

MR. A. W. GRAY, formerly county roads superintendent in Frontenac, Ont., will be made assistant provincial engineer of highways, and MR. ARTHUR SEDGWICK will, according to report, be appointed second assistant engineer of the Provincial Highway Department.

OBITUARY.

MR. EDGAR CHAPMAN, a mining engineer of New Liskeard, was found dead in his berth on the North Bay Grand Trunk Railway train. Mr. Chapman was connected with the Casey-Cobalt mines, north of New Liskeard. Two months ago his wife predeceased him after an illness of nearly three years. He was on his way to Toronto to spend the week-end with his daughter.

MEETINGS.

The Regina Engineering Society held their inaugural dinner at the King's Hotel on the evening of May 2nd last. Sixty-five members and guests sat down. After the usual toasts were proposed, the toast of "Canadian Industries" was proposed by Mr. Thornton, who pointed to the dependence of the success of our industries on the engineering

profession. Canada's now world-wide industrial reputation must be upheld largely by her engineers.

Mr. Haggarty replied by drawing attention in particular to Saskatchewan's possibilities for industrial development.

An address on "The Future of the Engineering Profession in the West" by A. J. McPherson followed. The speaker spoke of the growing importance and variety of these industries to our national life. The engineering profession has a wide field in the development of Canada's coal, forest and water power resources, as well as in the solving of the many engineering problems of our new cities.

In all these matters the responsibility and opportunity of the profession are of the very greatest.

"Our Railway Systems" was proposed by Mr. Martin, who spoke of the place of engineers in the forefront of every problem of transportation, of water power, of water supply, and of all other problems affecting national welfare. Saskatchewan, he said, offered alluring opportunities for the engineer because of her great and as yet but barely developed resources, and the engineering problems they present. The railroads are one of the most important factors in this development and the engineer has a broad field of usefulness open to him in railway work.

COMING MEETINGS.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—May 22nd-25th. Annual Convention at Chicago, Ill. Secy., D. B. Sebastian, La Salle St. station, Chicago.

FOURTH NATIONAL CONFERENCE ON CITY PLANNING.—May 27th-29th. Meeting, Public Library, Boston, Mass. Sec'y, Flavel Shurtleff, 19 Congress Street, Boston, Mass.

AMERICAN WATER WORKS ASSOCIATION.—June 3rd-8th. Annual Convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N.Y.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithica, N.Y.

ONTARIO MUNICIPAL ASSOCIATION —Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. · Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION. - President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont ; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION —President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President, J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council :—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA —President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close — Noted in issue of

5-15 Reinforced arch bridge, Guelph, Ont...(P. & S.) 5-2
5-25—Sanitary sewer, Islington, Ont. .....(P. & S.) 5-16
5-29—Water works, sewerage and electric light systems, Melfort, Sask. .....(P. & S.) 5-2
6-10—Electrical equipment, Vernon, B.C. .....(S.) 5-16

(Melfort plans and specifications are also on file at The Canadian Engineer Offices, 820 Union Bank Building, Winnipeg, and B33, Board of Trade Building, Montreal).

(Vernon specifications are on file at The Canadian Engineer Offices, Winnipeg and Montreal; Canadian Electrical News, Toronto; Contract Record, Toronto; Mather, Yuill & Company, Limited, Consulting Engineers, Vancouver, B.C.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Australia, steel rails and fish plates	May 29.	May 2.	60
Aylmer, Ont., library	May 15.	May 9.	60
Calgary, Alta., timber structures	May 15.	Apr. 18.	76
Chatham, N.B., passenger station	May 16.	May 9.	62
Edmonds, B.C., reservoir	May 20.	May 9.	60
Fort William, Ont., garbage incinerator	May 15.	Apr. 18.	74
Fredericton, N.B., culvert	May 20.	May 2.	60
Guelph, Ont., bridge	May 15.	May 2.	72
Hamilton, Ont., castings, meters, etc.	May 30.	May 2.	72
Lebret, Sask., school house	May 31.	Apr. 25.	61
Lunenburg, N.S., sewerage system	June 1.	May 9.	60
Montreal, Que., city hall annex	May 20.	May 9.	60
Moose Jaw, Sask., paving	May 15.	Apr. 25.	72
Melfort, Sask., waterworks, sewerage, etc.	May 29.	May 2.	72
North Battleford, Sask., boiler, steam engine, etc.	May 15.	May 2.	60
Ottawa, Ont., coaling stations	May 31.	May 9.	72
Ottawa, Ont., station and other buildings	May 31.	May 9.	74
Ottawa, Ont., dredging	May 15.	May 2.	60
Ottawa, Ont., steel tug	Apr. 22.	Apr. 11.	60
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., fishing protection vessel	June 17.	Apr. 18.	74
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Quebec, Que., leasing of water-powers	June 26.	May 2.	72
Regina, Sask., electric supplies, Sec. 6 to 9	May 15.	Apr. 11.	72
Saskatoon, Sask., garbage incinerator	June 25.	May 2.	74
Saskatoon, Sask., superstructure 23rd Street subway	May 17.	Apr. 18.	76
Sault Ste. Marie, Ont., sewerage works	May 27.	May 9.	76
Sault Ste. Marie, Ont., cement walks	May 27.	May 9.	76
Sault Ste. Marie, Ont., dredging	May 20.	May 9.	62
Toronto, Ont., bridge	May 23.	May 9.	72
Toronto, Ont., main drainage works	June 4.	May 9.	74
Trout Cove, N.S., breakwater	May 23.	May 9.	60
Upper Maugerville, N.B., wharf	May 23.	May 9.	60
Varna, Ont., drainage work	May 15.	Apr. 25.	62
Vancouver, B.C., water pipe and gate valves	May 15.	Apr. 25.	62
Vancouver, B.C., bridging, grading, etc.	May 31.	May 9.	62
Winnipeg, Man., pipe sewer	May 15.	May 9.	62
Winnipeg, Man., sewer pipe	May 15.	May 9.	62
Winnipeg, Man., electric locomotive, etc.	May 15.	May 2.	60

TENDERS.

Broadview, Sask.—Tenders for the construction of a skating rink at Broadview, will be received by A. Sinclair, Town Clerk, up to May 27th, 1912. Plans, etc., at the office of the Town Clerk, Broadview, or office of architect, Hugh G. Holman, 11-12 Jordan Building, Winnipeg.

Edmonds, B.C.—Tenders for the construction of an extension to Reservoir No. 1, in D. L. 189, for the municipality of Burnaby, will be received until Monday 20th, 1912. Particulars may be obtained at the office of the Engineers, Cleveland and Cameron, 506 Winch Building, Vancouver. W. Griffiths, Comptroller, Edmonds.

Edmonton, Alta.—The City Commissioners are inviting tenders for grading and the construction of boulevards on six miles of residential streets, work to be put in hand at once.

Guelph, Ont.—Tenders will be received up to May 18th, 1912, for the erection of a factory building at Guelph for the Dominion Linen Mfg. Co., Ltd. Particulars at the office of Colwill, Tanner & Co., architects, Traders Bank Bldg.

Hamilton, Ont—Tenders for supplying the Corporation of the city of Hamilton with two units of synchronous motors for direct connection to turbine pumps with transformers, switching apparatus and accessories complete, also for two units of turbine pumps, each of a capacity of 6,500,000 imperial gallons per 24 hours, for direct connection to synchronous motors, will be received until June 3rd, 1912. Specifications at the office of the City Engineer. (See advt. in Canadian Engineer).

Islington, Ont.—Tenders will be received until May 25th, 1912, for the construction of a 6 and 10-inch sanitary sewer on Fifth and Morrison Streets, New Toronto, from the northerly limit of Lot 392, plan 1692, on Fifth Street to the centre of Morrison Street, and easterly on Morrison to main sewer on Fourth Street. Plans, etc., at the office of The Canadian Engineer, Toronto, and J. A. L. Macpherson, Clerk and Engineer, Islington, Ont. (See advt. in Canadian Engineer).

Kerrisdale, B.C.—The council for the corporation of Point Grey is prepared to receive tenders for fire fighting apparatus for the municipality to be in by 5 p.m., Monday, May 27th, 1912. H. Floyd, C.M.C., Kerrisdale.

London, Ont.—Tenders will be received at the office of the City Clerk until noon May 18th, 1912, for the construction of cement walks in the city of London. Specifications at the office of the City Engineer. (See advt. in Canadian Engineer).

Montreal, P.Q.—Tenders for the supply and delivery of the following general supplies and various materials required for the different departments of the municipal service during the year 1912-1913, will be received up to noon of May 21st, 1912, by L. N. Senecal, secretary, Commissioners' office, City Hall, Montreal:—1. General supplies, macadamizing stone, and screenings, inorganic dust, lead pipe, pig lead, ingot tin and bituminous and anthracite coal, lumber, brick, vitrified clay pipes and inverts, hardware, spikes, paints and oils, lubricating and burning oils, iron and brass castings, gullies, pitch, coal, tar, dualine, detonators, fuse, street names and house numbers and sundry other materials. 2. For the purchase of scrap iron, steel, brass, copper, zinc, rubber, leather, waste paper, etc., etc.

Moose Jaw, Sask.—Tenders for water work fittings will be received by the City Commissioners up to noon on May 30th, 1912. (See advt. in Canadian Engineer).

Moose Jaw, Sask.—Tenders for the erection of a concrete retaining wall and laying of a number of new sidewalks at the Collegiate grounds, will be received up to June 5th, 1912. Specifications to be seen at the Collegiate Institute. Clifford Kempton, secretary-treasurer.

Ottawa, Ont.—The Department of Public Works will receive tenders until June 4th, 1912, for the construction of a wharf or retaining wall at Owen Sound, Grey County, Ont. Plans, etc., at the Department; office of J. G. Sing, District Engineer, Confederation Life Building, Toronto; H. J. Lamb, District Engineer, Windsor, Ont., and on application to the Postmaster at Owen Sound, Ont.

Ottawa, Ont.—Tenders for the design and construction of the new steamship for Hydrographic Service for the Atlantic Coast, will be received up to noon of June 30th, 1912, at the office of G. J. Desbarats, Deputy-Minister of the Naval Service, Department of Naval Service, Ottawa. (See advt. in Canadian Engineer).

Ottawa, Ont.—The Department of Public Works, Ottawa, will receive tenders for the construction of a wharf at Fredericton, York County, N.B., up to June 4th, 1912. Plans, etc., at this Department; office of J. K. Scammell, Esq., District Engineer, St. John, N.B.; Geoffrey Stead, District Engineer, Chatham, N.B.; and on application to the Postmaster at Fredericton, N.B.

Ottawa, Ont.—Tenders for the reconstruction of an approach to the Government wharf at Sault Ste. Marie, Ont., will be received up to June 4th, 1912, plans, etc., of which may be seen at the office of the Department of Public Works; J. G. Sing, District Engineer, Confederation Life Building, Toronto; H. J. Lamb, District Engineer, Windsor, Ont.; on application to the Postmaster at Sault Ste. Marie, Ont. R. C. Desrochers, secretary, Department of Public Works, Ottawa.

Pembroke, Ont.—Tenders will be received by the Town Clerk, up to noon of May 18th, 1912, for the construction of a Carnegie Library, Pembroke, Ont., according to plans and specifications prepared by Francis C. Sullivan, Architect, Castle Building, Ottawa, which may be seen at the office of the Architect, or Town Clerk's office, Pembroke. A. J. Fortier, Town Clerk.

Pincher Creek, Alta.—Mr. G. D. Plunkett, secretary-treasurer of the town of Pincher Creek, will receive tenders for the erection of a municipal building until Monday, May 20th, 1912. Plans, etc., at the Builders' Exchange, Lethbridge; office of the town clerk, Macleod; secretary-treasurer, Pincher Creek; the architect, James A. Macdonald, Room 8, Dominion Block, Calgary, Alta.

Saskatoon, Sask.—Tenders for the erection and completion of an eight-room school building to be built for the town of Melfort, Sask., will be received up to noon of May 29th, 1912. Plans, etc., at the Winnipeg Builders' Exchange, and at the Saskatoon Builders' Exchange, also office of W. Wood, Melfort, Sask., and office of the architect, W. W. Lachance, top floor, Willoughby Block, Saskatoon.

South Nelson, N.B.—Tenders for the construction of a stone Court House with municipal offices, to be built in Newcastle, N.B., will be received until May 20th, 1912. Plans and specifications may be seen at the office of the County Secretary, P. Williston, Esq., Newcastle, or at the office of the architect. G. Percival Burchill, chairman of committee, South Nelson, N.B. Leslie R. Fairn, architect, Aylesford, N.S.

St. Lazare, Man.—Tenders for the construction of a bridge over the Qu'Appelle River at St. Lazare, according to plan from the Department of Public Works, Winnipeg, will be received up to May 24th, 1912. Henry Tillman, secretary-treasurer, St. Lazare, Man.

Toronto, Ont.—Tenders for the erection of a lock-up at South Porcupine, will be received up to Wednesday, May 22nd, 1912. Plans and specifications at the office of Cook & Mitchell, barristers, in South Porcupine, and at the Department of Public Works, Ontario. H. T. McNaughton, Secretary, Department of Public Works, Toronto.

Toronto, Ont.—Tenders for the supply of cast-iron penstocks for the high level interceptor, will be received up to noon, Tuesday June 4th, 1912. Plans and specifications at the office of the City Engineer. (See Advertisement in Candian Engineer.)

Toronto, Ont.—Tenders for storm overflow sewer main, Garrison Creek, section No. 2, will be received until noon of June 4th, 1912. Plans and specifications at the office of of the City Engineer. (See Advertisement in Canadian Engineer.)

Toronto, Ont.—Tenders will be received until May 25th, 1912, for the construction of a concrete arch bridge over Copelands Creek, between Concession 13 and 14, Township of Tiny, County of Simcoe. Plans and specifications at the office of Frank Barber, Civil Engineer, 57 Adelaide Street East, Toronto. (See advt. in Canadian Engineer).

Vernon, B.C.—Tenders for electrical equipment will be received by D. G. Tate, City Clerk, up to 3 o'clock p.m., June 10th, 1912. (See advt. in Canadian Engineer).

Victoria, B.C.—Tenders for the erection of a new schoolhouse at Scott Road, Delta district, will be received by the Public Works Department up to noon of May 22nd, 1912.

Winnipeg, Man.—Tenders for an apartment building on River Avenue, will be received up to Saturday, May 18th, plans and specifications of which may be obtained at the office of William Bruce, architect, 222 McDermot Avenue.

CONTRACTS AWARDED.

Brantford, Ont.—The contract for the new nurses' home has been let to Messrs. Secord & Sons here. The building will cost $36,000.

Calgary, Alta.—Messrs. Grant-Smith Company and McDonnell, of Vancouver, have been awarded the contracts for a million-dollar work on the irrigation block. This includes a concrete aqueduct to cost half a million, other concrete structures to cost $300,000, and thirty steel bridges to cost $100,000. The aqueduct, which is the first of its design to be constructed, will be 10,500 feet long, with a maximum height of 55 feet and will irrigate 100,000 acres of the Canadian Pacific block.

Calgary, Alta.—The contract for the construction of the machine shop, foundry and office building, of steel, concrete and brick, for the Pioneer Tractor Company's plant, has been secured by T. F. Hook, of Calgary, and A. Groff, of Chicago.

Cobalt, Ont.—The town council has awarded the contract for laying sidewalks in the town at all town property to J. J. Anderson, whose bid was $25 a thousand. Several thousand feet of the walks will be laid, and the work is to be commenced at once.

Fredericton, N.B.—The contracts for supplies for water and sewerage work during the coming summer has been awarded as follows: D. J. Shea, soil pipe, at 25 cents per foot; J. S. Neill and Sons, terra cotta pipe, at 12 cents per foot; R. Chestnut and Sons were awarded the contract for supplying the galvanized iron and cement. J. L. Feeney, City Engineer.

Moncton, N.B.—The New England Artificial Stone Company of St. John was awarded a contract for thirty thousand dollars' worth of concrete sidewalks, crossings, etc., to be laid in Moncton this year. The tender ranged from 14½ cents for class A. to 16 cents for class D.

Montreal, P.Q.—Contracts approximating $100,000 for sewers and street improvements for the town of Outremont, have been awarded by the Outremont Town Council, as follows: Sewer awards to R. T. Smith and Company, Van Horne Avenue, from Rockland Avenue to Hartland Avenue, $3,544. Outremont Avenue, between Van Horne and Deschamp, $3,066. Sewer awards to Messrs. Gilbert & Payee: Wilder Avenue, $4,917. Wiseman Avenue, between Van Horne and

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Deschamp, $2,905. Lajoie, from Querbes to Outremont, $5,-850. Bloomfield Avenue, from Van Horne to Deschamp, $2,-905. Champagnier Avenue, between St. Viateur and Bernard Avenue, $5,505.75. Marsolais Avenue, $2,137. Sidewalks contract was divided into two sections, and the quantities were A 20,000 and B 17,000 lineal feet. "A" section was awarded to Messrs. Contractors, Ltd., at 25 cents per square foot, and "B" section to R. T. Smith & Co., at 28 cents per square foot.

Moose Jaw, Sask.—Messrs. Wilson, Townsend & Saunders, of Moose Jaw, have received the contract for the construction of a reinforced concrete subway under the C.P.R. Company's tracks on Eleventh Avenue. Cost, $82,464.89.

Vancouver, B.C.—The British Columbia Permanent Loan Company has closed a contract with the Norton Griffiths Steel Construction Company for the erection of a magnificent ten-story modern office building in Victoria.

Vancouver, B.C.—The British Columbia Electric Railway Company has let the contract for the construction of the grading on its line on Nanaimo Street from Hastings Street to Broadway, to Messrs. Franklin and Shepherd. Messrs. Franklin & Shepherd have also received the contract for the grading preparatory to the double tracking on Fraser Avenue, South Vancouver.

Vancouver, B.C.—Messrs. M. P. Cotton & Company and the Canadian Mineral Rubber Company secured the largest share of the asphaltic mixture pavement contracts awarded by the board of works. Out of a total of 265,289 yards, covering sections of twenty-six streets, M. P. Cotton & Company obtained 100,000 square yards and the Canadian Mineral Rubber Company a like amount. T. R. Nickson & Company received 17,500 yards and the Columbia Bitulithic Company 15,000 yards. The former tendered on sheet asphalt and the latter on bitulithic. A balance of 32,789 yards was left over for future consideration. The amount represented in the laying of this amount of pavement will total almost $1,000,000.

Winnipeg, Man.—The contract for the bridge at St. Andrew's locks has been awarded by the Dominion Government to the Brown Construction Company, Limited, of Winnipeg. The contract calls for a bascule lift span operated by electricity which opens and shuts to allow boats to pass up and down the river. There will be upwards of 500 tons of steel required to complete this work as well as 25,000 cubic yards of concrete. The contract has to be completed in fifteen months. The contract price approximately is $150,-000.

Winnipeg, Man.—The contract for the erection of twelve additional rooms to the Britannia School was awarded to J. Dolmer, contractor, Winnipeg, for $88,900. E. D. Tuttle, Architect, 701 McArthur Building, Winnipeg.

Winnipeg, Man.—Two deep well turbine pumps: Messrs. Stuart Machinery Co., Winnipeg, at $4,575 each.

RAILWAYS—STEAM AND ELECTRIC.

Brandon, Man.—The buildings and plant of the Maple Leaf Milling Company at this point were destroyed by fire on May 10th last. The loss is estimated at $40,000.

Montreal, P.Q.—A report states that the management of the Grand Trunk Railway have recently placed freight car orders as follows:—1,000 box cars with the Western Steel Car and Foundry Company, of Chicaga; 2,000 box cars with the Canadian Car and Foundry Company, of Montreal; 250 auto cars with the American Car and Foundry Company, of Detroit; 250 auto cars with the Western Steel Car and Foundry Company, of Chicago; 250 refrigerator cars with the American Car and Foundry Company, of Detroit; 250 refrigerator cars with the Canadian Car and Foundry Company, of Montreal; 1,000 new steel hopper bottom coal cars with the Pressed Steel Car Company of Pittsburg.

Montreal, P.Q.—A report states that the Canadian Pacific Railway Company has ordered 250 new engines and 12,-500 box cars. It is altogether likely this is the largest amount of rolling stock ever placed on order at one time in this country.

Prince Albert, Sask.—Work was commenced on May 6th on the survey of the Canadian Northern Railway Hudson Bay road from this city.

Smiths Falls, Ont.—The Canadian Pacific Railway will commence construction work on a foot subway to accommodate traffic on that street. It will be 110 feet long, 10 feet wide, and seven and a half feet high, and will be built of white tile. It will be brilliantly lighted by day and by night, and will be maintained by the company except for the lighting, which will be done by the town.

St. Catharines, Ont.—Negotiations have been commenced to construct a belt line in connection with the lines of the Niagara, St. Catharines and Toronto Railway. It is reported that an extension of this railway to Niagara-on-the-Lake is contemplated.

York County, Ont.—The management of the Toronto & York Radial Railway will place sixteen new cars on their line during the coming season.

LIGHT, HEAT AND POWER.

Galt, Ont.—During the first eleven months' operation of the Hydro-Electric Department in Galt the financial statement shows the department to have made $7,510, a net profit for the town. In order to complete the ornamental and bracket lighting of the town, making extension of power and light and other services, the Hydro-Electric Commission finds that $45,000 more will be required to equip this work.

Medicine Hat, Alta.—The ratepayers will be asked to vote on June 3rd next to decide a by-law calling for the expenditure of $50,000 on electric light improvements, and $75,000 for extension of the gas system.

Moose Jaw, Sask.—The municipal superintendent of electrical matters has prepared drawings for a new ornamental lighting standard. It is materially different from those now in use, inasmuch as the first two lights are on arms elevated from the side of the post, while the second pair are immediately above the lower ones, but not extended as far from the post centre. The fifth light surmounts the standard.

Northern Ontario.—Five more towns in the northern part of the province will be served by the Hydro-Electric Power Commission—Barrie, Stayner, Collingwood, Coldwater and Elmvale. Preliminary estimates have been submitted by the commission to the town of Barrie for a supply of power under contract between the commission and the Simcoe Railway & Power Co., developing at the Big Chute Falls on the Severn River. An extension of the lines built by the commission supplying Midland and Penetang will be made to the five new municipalities in the Hydro-Electric belt. Final estimates will be submitted to these towns in the course of a week or two.

Regina, Sask.—The equipment at the power house will be materially increased within the course of the ensuing year. Provision has been made for the purchase or a street railway unit similar to the one already in use. Although extensions were made to the lighting plant during the early part of the present year, it will be necessary to purchase still another large lighting unit. It will be installed early in 1913.

Saskatoon, Sask.—As a result of the investigation of the conditions and possibilities of developing power on the South Saskatchewan, below the city of Saskatoon, H. M. E. Evans, head of the Saskatoon Power Company, has reported to the city council that 14,000 horsepower could be generated at a total construction cost of $2,200,000. The cost includes the electrical equipment for delivery of power to the city limits.

The estimate was made by a party of engineers from Stone & Webster, Boston, Mass. The original estimate of Canadian engineers was 4,000 horsepower at a cost of $866,-000. On the basis of those figures an agreement was entered into by the city with the company to buy the entire output at $33 per horsepower delivered.

GARBAGE, SEWAGE AND WATER.

Province of Saskatchewan.—A report states that the Government of Saskatchewan, the Canadian Pacific, the Canadian Northern and the Grand Trunk Pacific railways have entered into a compact to divert the south Saskatchewan River to supply drinking water to Regina, Moose Jaw, Weyburn

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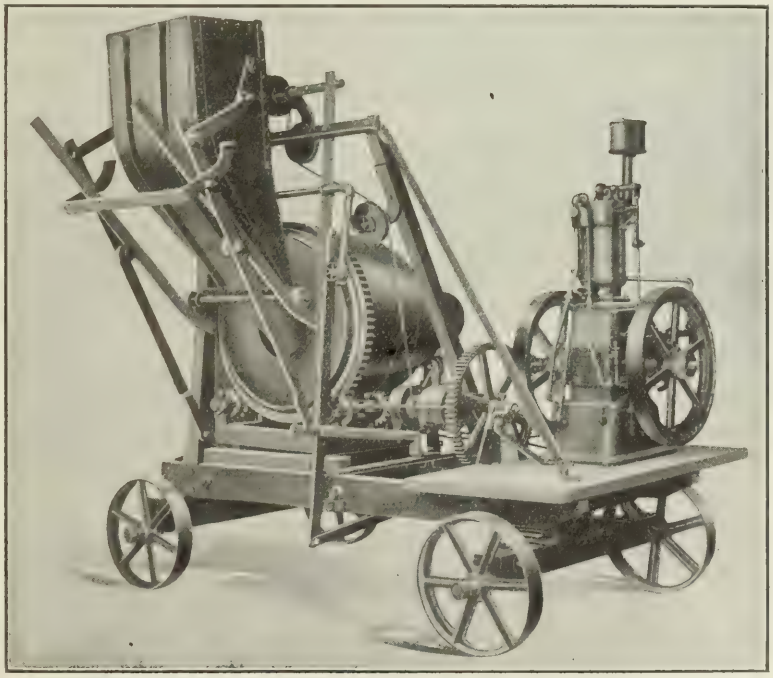

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and other towns and cities in Saskatchewan. The work will cost ultimately $20,000,000.

Mr. T. Aird Murray, C.E., of Toronto, is the consulting engineer and a member of the commission.

Vancouver, B.C.—A waterworks by-law will be placed before the ratepayers at an early date. This is for the purpose of raising funds to complete the laying of a water main into the district of Point Grey. The first expense for the city in connection with this by-law will be about $175,000.

BUILDINGS AND INDUSTRIAL WORKS.

Athabasca Landing, Alta.—A deputation from this town has been in Ottawa to secure pulpwood concessions and authority to erect a pulp mill at this point. It is claimed that there is a great deal of suitable materials and abundance of natural gas. Mr. James Wood, of Athabasca Landing, is interested in the project.

Battleford, Sask.—The Overland Manufacturing Company of Vancouver, will establish a plant in Battleford for the manufacture of doors, sash, and all kinds of woodwork.

Calgary, Alta.—Mr. Russell, formerly chief engineer of the Temiscaming and Northern Ontario Railway, and Mr. Wilson of Saskatoon, have approached the new Industries' Committee, with a view of establishing a sand, lime, and pressed brick plant on one of the city's industrial sites. They guarantee that if they could secure a suitable site they would put in a plant of $100,000 and employ about 40 men.

Cobourg, Ont.—The ratepayers will vote on a by-law calling for the exemption of The Canadian Ohio Motor Car Company from taxation, excepting school taxes, for ten years and to grant the company a sum not exceeding $1,000 for the purchase of a site. Mr. H. I. Matthews, Lakefort, has been elected president and managing director.

Eastern and Central Ontario.—The Commissioners of the National Transcontinental have prepared plans for the construction of six 200-ton mechanical coaling plants with sand houses and track approaches at the following points on the line: Moncton, N.B.; Napadogan, N.B.; Edmunston, N.B.; Grant, Ont.; Calvert, Ont., and Armstrong, Ont. A 1,000-ton coaling station with inclined trestle approach is also planned at Cochrane, Ont. Tenders for all these plants are now being called for.

Fort William, Ont.—Mr. A. E. Fenton will construct an elevator with storage capacity of 35,000 bushels. It is reported that this is the forerunner of fifteen others of a similar type to be erected in the near future.

Galt, Ont.—Preparations have been made for the construction of a drill hall in this town to cost about $15,000. It is to be 80 × 130.

Goderich, Ont.—The Canadian Pacific Railway will commence building operations on a new flour storage building to cost about $20,000. It is to be 200 × 40 and entirely of wood construction.

Lindsay, Ont.—A site has been selected for the new armory building, and it is probable that building operations will be commenced at an early date. Captain H. Hughes, Cd. Engineer, R.C.E., of Kingston, selected the site.

London, Ont.—The management of the Dominion Abattoir Company will erect a $75,000 building. Mr. E. Rechnitzer is at the head of this company.

Moose Jaw, Sask.—Plans for Moose Jaw's first skyscraper have been prepared, which is to be built by the real estate and automobile firm of Manley, Loney and Company. The building is to be erected at the corner on Athabasca and Main Streets. It is the intention to build the first two stories of the building this year, and the foundation will be built to carry a ten-story building. The building is to be reinforced concrete, and the Turner system is being considered. It will have an imposing front on Main Street, and the foundation will cover an area of 54 feet by 125 feet.

Moose Jaw, Sask.—The Board of Education have passed a by-law calling for $65,000 to be raised for school buildings.

Moose Jaw, Sask.—The ratepayers will be asked to vote on a proposed expenditure of $25,000 for the completion of the public library.

Montreal, P.Q.—The Federal Government plan to erect a new postoffice in the district of Westmount during the coming summer. The cost of this work will be $100,000.

Port Arthur, Ont.—A report states that the Regina Trading Company will erect a three-story steel and office building to cost about $70,000. Messrs. H. W. Laird and Peacock, of Regina, are interested.

Regina, Sask.—A new civic building law has been presented to the council for consideration. Protection from fire is especially aimed at, and for this purpose the bill proposes that 125 feet or ten stories be the extreme limit of height in future buildings to be erected.

Regina, Sask.—The management of the Westman Agencies, Limited, have under construction a new six story building, 85 × 110. Messrs. Reilly, Dawson and Reilly are the architects. The cost of this will be about $140,000.

Saskatoon, Sask.—It is reported that the C.P.R. has purchased a plot of land in this city adjoining the Bank of Montreal, and on the site it is proposed to erect one of the best office buildings in the West, to be used largely by the different departments of the company.

Western Canada.—Ten small elevators of the Saskatchewan Co-operative Elevator Company are being established between Regina and Griffin, along the line of the Regina-boundary branch of the Grand Trunk Pacific.

West Vancouver, B.C.—The council of this municipality have had plans prepared for the erection of a new town hall. Mr. J. C. McKenzie is the designer of the building.

BRIDGES, ROADS AND PAVEMENTS.

Calgary, Alta.—The municipal council are considering plans prepared for a bridge to serve Crescent Heights and Sunnyside. The plans of this bridge shows the southern approach to be between First and Second Avenues, and the amount of cutting which would be done at the top of the hill would depend entirely what grade was desired. A grade of about 6½ per cent. would not require a very deep cut. Archways at the north side would allow traffic underneath, and the height of the bridge on the north side of the river would be about 50 feet. The cost of a concrete bridge of this design would be, according to present figures, about $780,000.

Medicine Hat, Alta.—Much publicity is given a report in this district to the effect that the Canadian Northern Railway will enter the city from Police Point. Should this be true a large bridge will be required to span the river.

CURRENT NEWS.

Calgary, Alta.—The municipal council are taking steps to secure information on a project which has for its object the formation of a civic coal supply and it is not improbable that this city will shortly be operating its own coal property and selling fuel to residents at a price only slightly in excess of the cost of production. The members of the council are practically unanimous in favor of a muncipally owned coal mine, which, as municipal affairs go, is an innovation.

Fort William, Ont.—The municipal Fire, Water and Light Committee have received a request from the chief of the Fire Department that he be furnished with a new steam engine and an auto chemical hose wagon. The cost of these will be $13,000.

Ottawa, Ont.—The Railway Commission have requested the Railway Board to enforce an order to the effect that existing regulations regarding locomotive draft control be abolished, and a new set drafted by the commissioners. These new regulations provide that all engines must be fitted with netting mesh to prevent the escape of sparks, and that every railway company must provide inspectors at terminal points whose duty it shall be to examine from April 1 to November 1 each year all locomotives in use.

The proposed regulations given the chief fire inspector or any authorized officer of the board the power to inspect locomotves at all times, and to reject those found to be defective in regard to the fire arrangements.

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ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16393—April 27—Directing C.N.R. to divert ballast pit track and clear shrubs and trees away at crossing known as Rosslyn Rd., Twin City Junction, Ont.

16394—April 25—Dismissing application of Trans. Bureau of Montreal Board of Trade re corn and cornmeal rates from Montreal to points in the Maritime Provinces.

16395—April 23—Refusing application of the Canadian Freight Assn. for revision of Order 6844, Apr. 6, 1909, re commodity rates on wire fencing and netting.

16396—April 23—Authorizing C.P.R. to construct its second track across Melville-Regina Branch of G.T.P. at Regina, Sask. Additional interlocking appliance to be installed.

16397-98—May 1—Authorizing C.P.R. to reconstruct bridge No. 7.3 and 17.0 on its Ingersoll and Sudbury S.D.

16399—April 27—Directing all express companies subject to Board to prepare tariffs or supplement to Express Classification showing a scale of charges for the return of the proceeds of C.O.D.'s upon other than "merchandise" rate basis, and file the same within three months from date of this Order.

16400—April 23—Naming express delivery and collection limits of city of Sydney, N.S.

16401—May 1—Authorizing village of North Red Deer to construct highway over tracks of C.P.R. at Cherry Avenue.

16402—April 30—Approving clearance of 18 feet for dump cars only into clay shed of Alberta Clay Products Co. by C.P.R. Siding at Medicine Hat, Alta.

16403—April 30—Extending until 31st August, 1912, time for completion of bridge across Shubencadie River at South Maitland, N.S., by Dominion Atlantic Railway.

16404—April 29—Authorizing Algoma Central & H.B. Ry. to construct bridge over Michipicoten River.

16405—April 20—Authorizing C.P.R. to construct siding for the Seaman, Kent Co., Ltd., town of Outremont, Quebec.

16406—April 29—Authorizing C.P.R. to reconstruct bridges 19.4 and 46.9 on Havelock and Megantic Subdivisions.

16407—April 29—Authorizing C.P.R. to construct an extra track across South Bay Road, Parish of Lancaster, Ct. St. John, N.B.

16408—April 30—Authorizing C.P.R. to operate its trains over Pacific Avenue, Fort William, and St. Railway account remodelling of interlocking plant completed.

16409-16410—April 25—Authorizing C.P.R. to construct spur for the Calgary & Western Lumber Co., at Bengal, Alta., and for the Canadian Sardine Co., at mileage 23.31 on St. Andrew's Branch, County of Charlotte, N.B.

16411—April 19—Providing for protection at crossing of Toronto Suburban Ry. and G.T.R. stock yards branch at Keele St. and St. Claire Avenue, Toronto.

16412-13—April 29—Authorizing G.T.R. to construct a track to connect with C.P.R. spur serving Standard Sanitary Mfg. Co., and to operate over said track in Toronto, and to construct spur for Steel and Radiation, Ltd., 6th Con., Twp. of Grantham, Ct. Lincoln, Ontario.

16414—April 29—Authorizing G.T.R. to reconstruct bridge No. 346 at mileage 198.03 on 6th District, Northern Division.

16415—April 30—Approving location of G.T.R. station at Rockwood, Ontario.

16416—April 29—Authorizing C.N.O. Ry. to construct across public road between Cons. A. and 1, Ottawa Front, Twp. of Nepean, Ont.

16417—April 29—Authorizing C.P.R. to construct spur line from its Swift Current Extension to serve Moose Jaw Clay Products Co., spur being 1.01 miles in length.

16418—April 29—Authorizing C.N.O. Ry. to construct over lead vein on the property of North American Smelting Co., Ltd., in Twp. of Loughborough, County of Frontenac, Ontario.

16419—April 29—16420—April 30—Authorizing C.N.O. Ry. to construct spur for W. J. Lawrence, village of Richmond Hill, Ont., and C.N.R. to construct spur for Newcastle Coal Co. at mileage 171.73, Alberta.

16421—April 30—Approving revised location of C.N.O. Ry. (Montreal-Port Arthur Line) in Twp. of Ross, Ct. Renfrew, mileage 62.09 to 66.19 from Ottawa.

16422—April 29—Approving location of C.N.O. Ry. through unsurveyed territory in Dist. of Thunder Bay, mileage 383 to 398 from Sudbury Junction.

16423—April 29—Approving location of C.N.R. through Twps. 26-28, Ranges 8-15, west 3rd M., Sask., mileage 0 to 49.59.

16424—April 30—Authorizing C.N.O. Ry. to cross forced road and township road in Twp. of Nepean, Ct. Carleton, Ont.

16425—May 2—Approving location of C.P.R. station at Weyburn, Saskatchewan.

16426—April 12—Approving location of Algoma Eastern Ry. Co.'s station at Espanola, in Twp. of Merritt, Ontario, Sudbury District.

16427—April 30—Approving Essex Terminal Railways Standard Tariff of Maximum Freight Tolls to apply between Walkerville and Windsor, Walkerville and Sandwich, and Windsor and Sandwich.

16428-29—May 3—Directing C.P.R. (Walkerton & Lucknow Ry.) to install electric bell at crossing of Hutton Hill Highway, Twp. of Bentinck, Ct. Grey, Ontario; and electric bell C.P.R. at Locust Hill, Ontario, within 90 days from date of these orders, 20 per cent. from Railway Grade Crossing Fund.

16430-31—May 2—Authorizing C.P.R. to construct and operate two spurs for T. S. Sims & Co., Ltd., at Fairville, N.B., and spur for George W. Upham, Parish of Southampton, Ct. York, N.B.

16432—May 2—Authorizing C.N.O. Ry. to cross Symes Road, Toronto.

16433—May 2—Authorizing C.N.O. Ry. to reconstruct bridges 24A and 24B crossing Kaministiquia River, at mileage 23.2 and 24.3, from Port Arthur.

16434—April 30—Authorizing C.N.R. to expropriate certain lands for road diversion and to file plans for overhead crossing; diversion or bridge to be completed before 1st September, 1912. Application, R. M. Kindersley, Sask.

Tenders Called For

THE CORPORATION OF THE TOWNSHIP OF ETOBICOKE.

TENDERS WANTED.

Sealed tenders, addressed to the undersigned, and endorsed "Tenders for Sewer," will be received by the Corporation of the Township of Etobicoke up to 3 o'clock p.m., the 25th day of May, 1912, for the following work, viz.:—

The construction of a 6 and 10-inch Sanitary Sewer on Fifth and Morrison Streets, New Toronto, from the northerly limit of Lot 392, plan 1592, on Fifth Street to the centre of Morrison Street, and easterly on Morrison to main sewer on Fourth Street. Plans and specifications may be seen at the office of the undersigned, or at the office of The Canadian Engineer, Toronto.

Tenders must be made on forms to be obtained from the undersigned, and must be accompanied by an accepted cheque for 5 per cent. of the amount of the tender, payable to the order of the Township Treasurer. The accepted cheque of the successful bidder shall remain in the hands of the Corporation until the work is satisfactorily completed.

The lowest or any tender not necessarily accepted.

J. A. L. MACPHERSON,
Clerk and Engineer, Islington, Ont.

Dated this 14th day of May, 1912.

BASSANO.

TENDERS FOR ELECTRIC GENERATING MACHINERY.

Sealed tenders, marked "Tender for Electric Generating Station Equipment," and addressed to S. E. Whiting, Esq., the Bassano Electric Power and Traction Company, Bassano, Alta., will be received by the undersigned at 6 p.m. of the third day of June, 1912, for the delivery and erection of the following machinery and apparatus:—

Section "A" Two Return Tubular Steam Boilers,
Section "B" One Steam Engine,
Section "C" One Electrical Generator and Equipment.

A marked cheque for 5 per cent. of the amount of the tender shall accompany each tender.

Tenders are invited for each section separately.

Specifications may be obtained from S. E. Whiting, Esq., Bassano, Alta., or from the Engineers, Messrs. Bowring & Logan, 322 Donald Street, Winnipeg, or may be seen at the office of Norman A. Hill, 43 Victoria Street, Toronto, or at the offices of The Canadian Engineer, 62 Church Street, Toronto, and 33 Board of Trade Building, Montreal.

BOWRING & LOGAN, Engineers, Winnipeg.
S. E. WHITING, President, Bassano.

(Tenders also on pages 72, 74 and 76).

RED DEER'S GROWTH.

April returns show the expansion in Red Deer, Alberta, continues. The building permits for the first four months of 1912 are $84,685, compared with $33,785 for 1911, which was a record for Red Deer up until that time. This is a gain of nearly two and a half times, or 250 per cent. Every department of business shows large increases. The passenger receipts are double those of April, 1911, and the freight, express, telegraph receipts have been very heavy. The local staff is rushed to handle their business, even with increased help.

In regard to customs, Red Deer was made a port of entry on April 1st, and the business done since then has shown the great need there was for such an office. At the rate of the business done since the office was opened, Red Deer will have more business during its first year than any port in Western Canada except Winnipeg. The receipts will be greater, too, than seven of the eleven western points up until two years ago, and will exceed that of several places of more than double Red Deer's population last year.

Volume 22. Toronto, May 23, 1912

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The Canadian Engineer

An Engineering Weekly

GRADE ELIMINATION AND BRIDGES.

By HENRY GRATTAN TYRRELL.

The subject of track elevation in the United States received but little attention until the year 1888, when the House of Representatives of Massachusetts appointed a commission to investigate and report on the subject of separation of grades for steam railroads and highways. The recommendations of the legislature were that grade crossings be eliminated, and that the expense of such work be borne

65% by the railroad companies
25% " " State.
10% " " local town or city.

In the two or three years following, the subject of grade elimination in Chicago was seriously considered, and in 1892 as a preparation for the approaching World's Fair in Jackson Park, Chicago, the Illinois Central Railroad undertook the raising of their tracks from Hyde Park to 72nd Street, Woodlawn, as in this district their tracks cross the principal avenues leading to the Fair Grounds.

In the same year a measure was introduced into the Chicago city council requiring a general raising of all the railroad grades entering the city. The population of Chicago was then about a million and a quarter, and there were 1,600 miles of track within the city limits, with 2,000 to 3,000 level crossings, over which upwards of 1,800 trains passed daily. The ordinance affected about thirty railroad companies, and required the elevation of 150 miles in line and the construction of 700 to 800 subways. So important an ordinance necessitating the expenditure of $75,000,000 or more, met with very serious opposition, and modifications were made requiring that parts only be elevated immediately, and the whole work spread over a period of years. A superintendent of track elevation was appointed, and portions of the work were soon commenced. The Chicago and Northwestern Railroad was one of those affected, and in the next few years portions of their various branches were raised, including about four miles of line on the Milwaukee branch between Diversey Boulevard and Balmoral Avenue, which was elevated in 1897. At a number of crossings in Chicago where the track is elevated on banks from 8 to 12 feet high, the streets beneath the tracks have been lowered from 4 to 6 feet, and graded back to the regular street lines. In Chicago and Evanston, it is impractical to depress the grades below the lake level, as provision for pumping would be necessary.

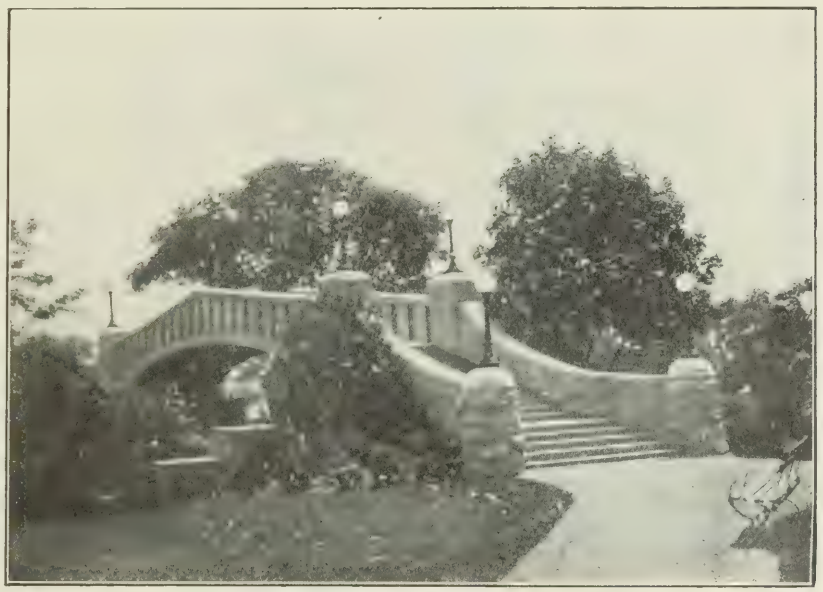


Fig. 1.—Forest Park Entrance, St. Louis.

This is an overhead bridge crossing when railway is depressed. It has a clear span of 50 feet, and spans two lines of track.

Evanston Work.—The method of track elevation used in Evanston is similar to that in Chicago, the country being all flat, and the grades insignificant. The city of Evanston, a residential suburb with a population of 25,000, lies directly north of Chicago, and the boundaries of the two municipalities meet. Two branches of the Chicago and Northwestern Railroad pass through the city, connecting with Milwaukee. In the morning and evening, during the hours of greatest travel, suburban trains run at intervals of three to ten minutes apart, averaging twelve per hour. Adjoining the steam railroad, are double tracks of the Northwestern Elevated Railroad, which is likewise elevated on an earth embankment, and where trains make stops at frequent intervals.

Grade removal was greatly needed, not only to avoid accidents, but also to make possible the running of faster trains between Evanston and Chicago. At some of the crossings several persons had been killed, and the fire risk was also increased by the level grades, because where trains are numerous fire engines might be delayed by them, and a few minutes' delay at the beginning of a fire might result in increased fire loss. Gates and flagmen are a partial protection but do not insure safety, as any provision depending on human watchfulness is sure, sooner or later, to prove disastrous.

*Consulting Engineer, Evanston, Ill. Mr. Tyrrell is a graduate of Toronto University in Civil Engineering of the class of 1886.

The general plan of track elevation in Evanston consisted in placing the steam railroad on an earth embankment, using retaining walls where the width of the railroad land was not sufficient for side slopes. At the street crossings, the bank was supported by abutments and the tracks carried over the streets on bridges, having three lines of columns in the streets, two at the curbs and one in the middle, dividing the street into right and left driveways. Travel was first diverted on a temporary track at one side of the permanent line, and pile trestles were then built on the permanent location over the streets and a sufficient distance at each side of the street to allow space for building the permanent abutments. In several places where the streets are fairly close together, the trestles were made continuous.

The railroad companies did all work at their own expense, unassisted by the city, and where street paving was removed for foundations, it was relaid by the railroad company. The driving of piles was carried on day and night with drop hammer pile drivers, and some Naysmith hammers making blows at intervals of two seconds. On the Melrose branch, only a part of the street crossings are bridged at present, the remaining ones where travel is light, being filled with earth banks, which can be removed and bridges substituted when the condition of travel demands it.

Much caution was needed in driving piles at the street crossings to avoid injuring the city sewers and water mains. When sufficient pile trestle work was built, sand filling was brought in by train and the bank made. The temporary side tracks were then removed and all travel turned over the bank and trestle. At several of the streets, when building abutment foundations, so much water was encountered that sheet piling was necessary. Two-inch tongue and grooved plank was used for this purpose and water pumped out of the excavations with hand pumps. Oak piles were driven in the excavations and were cut off three or four feet below street grade with hand saws.

Concrete was used almost exclusively for abutments and retaining walls, side walls being used only where the width of right-of-way is insufficient to hold earth slopes. Low walls are used in some cases near the toe of slope where enough land width was not available. High retaining walls are paneled on the face, but lower ones are plain, excepting for the presence of a coping. Vertical joints are left at distances of 15 feet apart for expansion. Little or no effort was made to remove form marks from the abutment faces, and these are very evident. Walls and abutments are of the solid gravity type, with backs stepped rather than sloped, and waterproofed with a coating of tar or asphaltum, which in many cases is not proving effective. Three lines of old rails are imbedded in the concrete, and at places where new walls are joined to old ones, a dovetailed joint is provided which not only permits expansion, but holds the two adjoining parts together.

Where the Northwestern Elevated Railroad adjoins the steam road, columns in the street correspond with those for the steam railroad bridges. The foundation in the centre of the street consists of a continuous wall pointed at the ends to serve as wheel guards, and standing a foot or two above the street level. On these walls are reinforced concrete columns, two under each line of track, with eight bars in each column, the four corner bars being larger than the others. At the depots are retaining walls between the steam railroad and the Northwestern Elevated Railroad, continuing far enough back from the street to form inclined driveways 24 feet wide, leading from the street up to the elevated grade. Stairways are built into the abutment faces at the depots, which lead up to the elevated platforms and shelters.

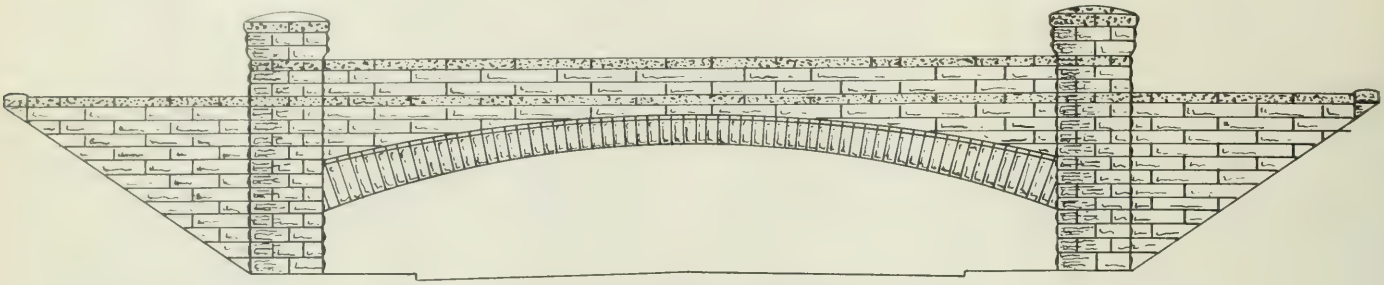


Fig. 2.—Main Street Crossing, Springfield, Mass.

Grade Elevation in Other Cities.—Various methods of grade elimination have been used in other cities, differing considerably in cost and appearance. All of these may be divided into two general classes,

(a) Those where the track is depressed,

(b) Those where the track is elevated.

The Boston and Albany Railroad through the Newtons, Mass., adopted a plan of depressing the railroad tracks and carrying the streets over on ornamental bridges. There is no doubt that this arrangement produces the most satisfactory results as far as the aesthetic effect is concerned, for the trains are then below the general level of the ground and there is no unsightly bank to obstruct the view, and divide the city into two parts. At Newton, in the vicinity of the depots, the side slopes are sodded and planted with flowering shrubs, which serve not only as ornaments in summer, but also to unite the soil and prevent the banks from sliding.

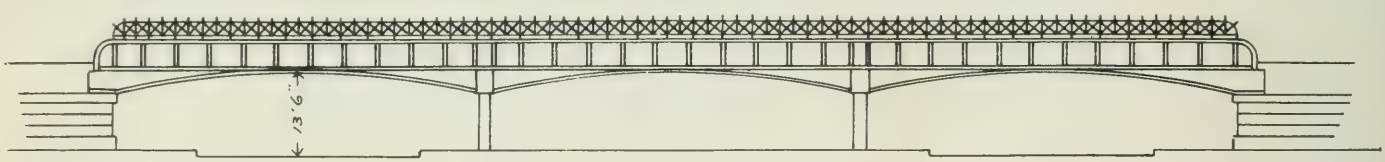


Fig. 3.—Garfield Boulevard Crossing.

Adjoining Forest Park, St. Louis, the Wabash Railroad adopted the plan of elevating the tracks on a bank of earth 15 feet in height. A view of this elevation at the main part entrance is shown in Fig. 1. The bridge over the main drive is quite a satisfactory solution of the problem as far as that feature is concerned, but the high embankment remains as a disfigurement to the otherwise beautiful surround-

ings. Such a bank forms an obstruction to the view of a beautiful park vista, that might be a permanent source of pleasure. The railroad bank may be hidden with trees or shrubs and its unsightliness concealed, but if conditions would permit, a better way would be to depress the tracks and leave a clear and unobstructed view.

The city of Springfield, Mass., has a railroad bank running across the city, but some of the street crossings have been made quite attractive, like the one shown in Figure 2.

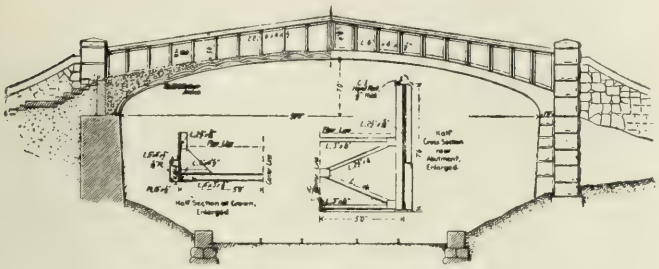


Fig. 4.—Foot Bridge, Madison, Wis.

The railroad is carried over Main Street on a stone arch, artistically designed with towers at either end and stone belt courses of different colors. The necessary head room underneath makes the use of an arch difficult in some cases, and when used, it must necessarily be a flat arch. The bridge at Springfield is so low at the springs that there is a sense of insufficient head room when walking on the sidewalk beneath the bridge. The extreme flatness of the arch also produces a feeling of insecurity and lack of strength which injures it aesthetically, for strength should, if possible, be emphasized in all bridges. Apart from the flatness of the arch, the general effect is quite satisfactory.

At Brockton, Mass., there are a number of ornamental overhead crossings, carrying lines of railroad over the

Fig. 5.—Park Bridge at Madison, N.J.

streets. These are built somewhat similar to that at Springfield, with stone arches, but at Brockton the long blank wing walls are unsightly and more prominent than the bridges themselves.

Garfield Boulevard, Chicago, is crossed by a set of railroad tracks which are supported by through plate girder bridges, shown in Figure 3. As the boulevard is quite wide, the bridge has three spans, and an effort has been made to relieve the straight overhead lines by using flat arches beneath the girders.

Other cities have treated the subject of grade crossing elimination in various ways, but generally either by track elevation or depression, as any great change in street grades is usually impracticable.

A plan used by the writer for grade elimination is shown in Figures 4 and 5. This bridge is in the park at Madison, N.J., and carries a foot walk over a double line of railway, which in this case is depressed instead of being elevated on an embankment. Similar treatment can be applied to street or highway bridges over railroad cuttings, either by lowering the railway or by grading up the street approaches instead of using steps, as in the illustration.

THE FLOW OF WATER THROUGH A POROUS MEDIUM.

By L. R. Balch.

The flow of water through a filter medium is a question of important practical application upon which our knowledge is so imperfect that a great deal of further investigating in the laboratory is required. The final object of such experimental research is to determine what factors influence the variation in results under various conditions, and what the effects of those factors are. In conducting the experimental investigations, the principal, and also the most difficult, thing is so to design the apparatus and conduct the tests that these various factors either be eliminated or be determined in effect. A large amount of work and a great deal of study is required before this can be accomplished. It often happens that, though an investigation promises to be comparatively simple, the additions and revisions found necessary as the work advances cause it to become quite complicated before satisfactory results are obtained.

Through the work done on this subject by Mr. Allan Hazen for the Massachusetts State Board of Health, and by Prof. C. S. Slichter, of the University of Wisconsin, a fair knowledge is had of the conditions influencing the flow of water through a soil column and of their effects. A number of conditions which have a very great effect on the rate of flow are quite difficult to determine, making the experimental work a matter of great care and thoroughness. The conditions which influence the rate of flow as shown by previous experiments will be taken up somewhat in detail.

The hydraulic gradient or difference in pressure from point to point, measured in the direction of flow, is the primary cause of the flow of liquid, and the greater the gradient, the greater will be the flow. The value of the hydraulic gradient is measured by means of gage tubes, similar to the piezometer tubes familiar to those acquainted with experimental hydraulics.

The porosity or amount of void space in the porous material has a great influence on the rate of flow, which varies directly with the porosity. In experimenting with a mass of spherical shot, Prof. Slichter found that a number of values for the porosity could be obtained with the same material, depending upon the arrangement or manner of packing. The minimum value was found to be 25.95 per cent. of the whole space occupied. The great effect of the porosity on the flow may be shown by a tabulation given by Prof. Slichter in Water Supply and Irrigation Paper No. 67, published by the United States Geological Survey. From this it appears that if the porosity of the same sample of sand is changed from 30 per cent. to 37 per cent., other conditions remaining the same, the flow in the latter case will be twice that in the former.

There are several methods which may ordinarily be used to determine the porosity of a sample of sand. Probably the

*From the Wisconsin Engineer.

most successful method is that used by Messrs. Cenfield and Urbutt, which is described in their thesis for the degree of Bachelor of Science in 1909. This method, by which repeated trials gave substantially the same results, is to fill the testing receptacle with thoroughly dry sand by allowing it to flow through a tube maintained at a constant height above the sand surface in the receptacle. Water is added through a pipe connected to the bottom of the apparatus from the outside. This method of filing the voids drives out the air as the water rises. A difference of two per cent. by weight was found in the amount of sand necessary to fill the apparatus in various determinations by packing the sand in any other way than by the tube method. This method has a disadvantage in that the tanks used in the flow experiments are not packed in the same way and the consequence is that the correct value for porosity to use in the computation of results is not known.

Probably the most satisfactory way would be to measure the void space in the sand when in place in the flow apparatus. This would be open to criticism, since the value obtained could not be checked, and in case the determination was incorrect, the results would be unreliable.

The larger the size of the separate pores, the greater will be the flow through the porous material. The value of this factor depends upon the "effective size" of the soil grain in the sample The flow through the interstices of an ordinary sand bed is similar to the flow through capillary tubes and is proportional to the first power of the head causing the flow. When the grains become about three millimeters or larger in diameter, the condition for free flow obtains and the flow varies in accordance with $\sqrt{2gh}$.

The method of determining the effective size will be briefly taken up in a discussion of Hazen's Formula.

The rate of flow varies directly with the temperature. This is because of the effect of temperature on the viscosity of water. An idea of the effect of change in temperature on the flow may be had from the fact that a change from 50 degrees to 60 degrees Fahrenheit will produce a change of about sixteen per cent. in the flow.

It has been found that the shape of soil particles is an influencing factor, though it is impossible to express it in the flow formulas. It is plain that sand grains that are round, flat, rough or smooth will have varying effects on the results even though the effective size is the same for each kind. Cleanliness, chemical composition and distribution of sizes in the sample also have greater or less effects upon the flow, but are exceedingly difficult to express. The distribution of sizes is shown by the "uniformity coefficient" used in selecting the value for C in Hazen's formula.

There are two accepted formulas for the flow of water through soil, one by Allen Hazen, resulting from his work at the Lawrence Experiment Station, and one by Prof. Slichter, resulting from his investigations of the flow of underground water.

The former is generally used by American engineers in their designs and has become standard. This formula is

$$V^2 = c\,d\,\frac{h}{L} - (0.70 + 0.03t)$$

V is velocity of flow in meters per day.

C is a constant depending for its value upon the shape, cleanliness, chemical composition and distribution of sizes of grain. In practice its value is assumed by comparison of the results of mechanical analysis of the given sand with those of a sand which has been tested.

d is the effective size of soil grain. It is the diameter in millimeters of a sphere whose volume is equal to the volume of that soil grain of such size that 10 per cent. of the grains in the sample are smaller. The size of grain is found by thoroughly shaking the sample through a set of sieves and finding that size which just will not pass each sieve. The results are platted and the effective size taken from the diagram. The size than which 60 per cent. of the sample is smaller divided by the effective size is termed the "uniformity coefficient," the comparative value of which is considered in selecting the proper value for C.

h is the loss of head or the head causing the flow measured between points just inside the ends of the soil column.

L is the length of sand column through which the water passes in losing the head h.

t is the temperature in degrees Centigrade. It may be noted that when t is 10° the last term of the equation becomes unity. The equivalent temperature, 50° Fahrenheit, is taken as the standard in Slichter's formula.

Prof. Slichter expressed his conclusions by the formula:—

$$Q = 0.2012\,\frac{h}{L}\,\frac{d^2\,a}{w\,k}$$

Q is the volume flow in cubic feet per minute.

$\frac{h}{L}$ is the hydraulic gradient and has the same value as is used in Hazen's formula.

d is the mean size of soil grain and is defined as that size such that if all the grains were the same, the flow would be what it actually is. This term takes care of the size of voids, the cleanliness, chemical composition, shape and distribution of sizes in the sample.

W is a number called the viscocity coefficient which depends upon the temperature for its value. It is defined as that force necessary to maintain unit difference in velocity between two strata of water unit distances apart.

K is a constant depending upon the porosity for its value. Tables of values of both K and W are given in the water supply paper previously mentioned.

Experiments which have been made show the necessity for observing certain principles in conducting investigations of the flow through sand.

Water used in the tests should be treated with some agent such as formaldehyde to prevent the growth of organic life, and should be filtered through charcoal before using. It has been found that water treated in this manner answers the purpose about as well as distilled water. The water should not be used in the tests a second time. In passing through the sand the water may dissolve material which affects its viscosity.

The temperature of the influent water should not be different than that of the effluent by more than one-half degree. In varying the temperature, the experiments should not be conducted at a temperature much above about 65° F. until a satisfactory amount of data has been taken at the lower temperatures. The reason for this is that the heated water seems to cause an entirely new arrangement of the material. The increase in temperature of runs should be made in small increments to discover the critical temperature if such exists.

SHIP-RAISING AT SARNIA.

The Steel Trust is using a novel method to raise the Joliet at Sarnia. It was found impossible for the divers to work on account of the current, so another boat will be sunk directly in front of the Joliet, which will break the current and enable the damage on the Joliet to be repaired. It is expected the scheme will be successful and the boat removed in a short time.

PROTECTING PIPE LINES AGAINST ALKALI.

The matter of the proper method of protection for pipe-lines when alkali is present is a very important one to the engineer. Many of the water supplies for our Western towns and cities must be conveyed through many miles of pipe, and adequate protection is a necessity. Mr. C. P. Bowie makes the following comment on the subject in the May issue of Western Engineering.

Most of the larger oil pools so far developed in the state of California lie in the arid districts. In the construction of pipe-lines through these districts, and leading from them to the sea-coast, one of the most serious problems the engineer has to solve is the question of an adequate protection for the pipe against alkaline soils. In the San Joaquin valley, through which the majority of these lines pass, the total alkali salts in the soils range from 0.05 up to 5 per cent., and the average composition of these salts in the soils is about as follows.

	Per cent.
Potassium sulphate	11.28
Sodium sulphate	19.48
Magnesium sulphate	2.89
Sodium chloride	23.03
Sodium carbonate	40.96
Sodium phosphate	2.08
Sodium nitrate	0.28
	100.00

In many places the percentages of chlorides and sulphates are much higher than shown. In such soils, steel pipes 5/16-inch in thickness, altho gh originally protected with three coats of asphaltum paint, have corroded so badly that pit-holes have developed, extending entirely through the pipe in three years' time. If the life of a pumping system be taken as 20 years, and the cost of the pipe installed in the system as 40 per cent. of the total first cost, it is obvious that a protective coating which will triple or even double the life of the pipe through bad territory, becomes an important factor.

Working along these lines, a number of coverings have been brought forward. Various kinds of asphaltum paint have been used, but, so far at least, without any marked degree of success. Crude oil has also been applied by covering the pipe after it has been lowered into the ditch to a depth of six inches or more with the oil, and then immediately filing in the ditch with earth. This method is only partly successful for the reason that if the soil is at all sandy the oil soaks into it, and in time almost entirely disappears from the vicinity of the pipe, leaving the metal quite as badly exposed to the alkali as before the application. Quick-setting bituminous enamels, which can be put on in a layer ⅛ to ¼-inch thick, bid fair to give results. However, up to the present, these have one serious drawback, in that they cannot be successfully applied to a moist pipe or to a pipe having a lower temperature than 60°F., because the enamel, although it is put on at a temperature of approximately 200°F., is chilled so rapidly that it hardens before it can be spread. The action of the mop with which it is applied is merely to roll it into a myriad of balls or globules which do not stick to the pipe at all but fall to the ground. This not only causes a great waste of material, but is apt to leave many small portions of the pipe, especially on the under side, wholly unprotected even though several coats of enamel are put on. This difficulty can be largely overcome by applying the enamel in warm dry weather only, or to pipes through which warm oil is being pumped. There are no lines in this state which have been covered by this process and allowed to remain in the ground for any great length of time. One line passing through slightly alkaline territory, which was covered in this manner about two years ago, was found to be in excellent condition upon a recent examination.

The method of covering most extensively used, and perhaps the most successful one, is that employing especially prepared roofing papers. The papers commonly used are those made from ordinary deadening felt run through a mill in which the felt is plunged into a number of successive baths of hot asphaltum and rolled hot and under pressure after each successive bath until the fibres of the paper are thoroughly impregnated with the asphaltum. Just before entering the last set of rolls the paper is sprinkled with either mica or soapstone, which mineral, while it no doubt adds somewhat to resistance against the attack of chemicals, has for its principal function the quality of affording a means of keeping the paper from sticking in the roll in hot weather Asbestos papers, prepared somewhat in a similar manner to the felt papers, have also been used in a number of places.

These papers are applied to the pipe by two methods, known locally as the "spiral warp" and "longitudinal lap." The spiral warp, which is in most cases the most efficient method, consists of applying the paper to the joints between collars by wrapping it around the pipe spirally. For this purpose, the paper is cut in the mill into rolls of the desired size, varying from 3 to 12 inches in width, and containing from 50 to 100 ft. in length as best suits the diameter of pipe to be covered. The pipe is covered immediately after being screwed together by the tong gang, and while still on skids over the ditch. It is coated with hot asphaltum and the wider strips wound on spirally before the asphaltum has had time to set. The crack which is left between each wrap of the wide strip is then coated with the hot asphaltum, and a batten, or 3-in. strip, wound on to cover it. The asphaltum used is a thin grade of the ordinary refined product, and is applied to the pipe at a temperature of about 200° F., and is of such a consistence that it will not set for about five minutes after application. If, due to climatic conditions or variance in the different shipments, the asphaltum sets too quickly, a so-called flux, which is simply a very thin grade of asphaltum, is added. It is usually the practice to ship one barrel of "flux" to the field for every 60 barrels of asphaltum. At the joints 3-in. strips stuck together with asphaltum are wound around the pipe on either side of the collar until a shoulder is built up flush with the outer circumference of the collar. The sleeve and shoulder thus built up are then coated with hot asphaltum, and the whole covered with a 12-in. strip of paper. Besides being stuck to the pipe with asphaltum, this last strip is bound on with wire, as are also the ends of the paper where it is wrapped spirally. If this is not done, the ends will curl up and allow dirt to get between the paper and the pipe after the pipe has been lowered into the ditch, and before the back-filling has been done.

The longitudinal lap system, which to the present time has been much more extensively used than the system just described, consists (as the name implies) of wrapping the paper longitudinally around the pipe. The paper is delivered in the field rolls, about 6 in. wider than the circumference of the pipe to be covered, each roll containing approximately 72 lineal feet. Two men go ahead of the paper gang and measure up each joint of pipe between collars and cut the paper into the desired lengths.

In applying the paper to the pipe, undoubtedly the best method is first to coat the pipe with hot asphaltum as previously described; then to wrap the sheet of paper around the pipe and stick down the lap with hot asphaltum. This, however, is not often done when covering lines where the oil passing through is to be heated, the supposition being that

the heat of the oil (usually about 130° F.) combined with the pressure of the earth on the pipe after it has been buried will be sufficient to soften whatever asphaltum there is in the paper and form the necessary bond between paper and pipe to keep the water out. Without question, this supposition is correct to a certain extent. The paper, especially where a heavy quality is used, will undoubtedly adhere to the pipe in most places where it comes in contact with the metal; but it is to be noted that roofing papers applied to a pipe, while still on skids above the ditch, and allowed to stand in the sun for a few hours, will stretch to such an extent that the contact will be found to be on the upper circumference only, there being often as much as one-quarter of an inch of space between the bottom of the pipe and the paper. It is a serious question if this same thing does not occur when the heat from the oil first reaches the paper, even though the pipe has been lowered into the ditch and covered up. The paper, of course, does not bag uniformly as in the case above ground, but the surplus is taken up in wrinkles, and these wrinkles are very apt to be connected for the entire length of a joint of pipe. Should any injury occur to one of these wrinkles, or a crack develop in it, which will undoubtedly be the case as oxidation goes on, it is not at all improbable that water, which would enter, would reach every place in a joint of pipe where the paper was not securely stuck on, and thus render the whole covering practically useless. Where asphaltum is used as a binder, the wrinkles that form will be filled, thus preventing the water from entering, even though the paper should in time crack at these points. Time alone, however, can solve this much-mooted question, since there are no lines in California protected in this manner that have been laid a sufficient length of time for these cracks to develop.

For covering the collars, the same method is used as with the spiral wrap, except that the binder is often omitted. This it would seem, is even more serious than omitting the binder from the main body of the pipe, since it gives the water a chance to get between the paper and pipe through the ends of the wrinkles.

Whether a binder is used or not, the lap should always be made on the top of the pipe with the outer portion of the lap looking down, and wires should be placed about every sixteen inches. This is necessary to prevent the paper from being pulled away from the pipe by its own weight before it can be lowered into the ditch and covered.

RATS AND PLAGUE.

The bacteriological examination of 100 rats, at the public health laboratory, of Manchester, England, which was commenced during the previous year, was completed in June last. No bacilli suggesting plague were discovered in any of the bodies, but in six cases parasitic cysts of the liver were found; in only one case were bacilli of a possibly pathogenic nature seen, but of course not plague producing; in nineteen cases putrefactive bacilli or cocci were discovered; in twenty-three trypanosomes were found in the blood. The last mentioned feature, although having no special indication so far as is known at the present time, is somewhat interesting. Trypanosomes are a species of protozoa or low form of unicellular animal parasite of a flagellate or whip-like shape which infest the blood of man and animals, and which are responsible for various diseases in reptiles, mammals, fishes, etc. One variety (trypanosomes gambiensis) produces sleeping sickness, and is introduced into the blood of human beings by means of a fly. Knowing the way these parasites are carried from one body to another, it is certainly interesting, if nothing else, to find so many of the rats thus infected.

NEW METHOD OF PURIFYING WATER.

What is understood to be a new method for the speedier purification of Thames water has been discovered by Dr. A. C. Houston, of the Metropolitan Water Board. He adds lime to raw water in such quantity as to kill all the germs. He states that when 1 part of quicklime (about 75 per cent. CaO) is added to 5,000 parts of raw Thames water, about .007 per cent. free CaO is left in the mixture, and this excess is sufficient to kill B. coli in from five to twenty-four hours. The result of this process is to make the water unusable on account of the quantity of lime in it, and Dr. Houston proposes to correct this by mixing it with natural water which has been purified by storage. It would require about one part natural water for three parts quicklime water to produce a potable mixture. Thus it would be sufficient to purify only a third of the water needed for London by storage. The rest could be dealt with by lime and then mixed. The principle is thus described by Dr. Houston:—

Fifteen lbs. of quicklime, costing three-halfpence, would be added to 7,500 gallons of raw unstored Thames water. This would kill within twenty-four hours the B. coli, and inferentially, but certainly, the microbes also of epidemic water-borne disease (e.g., the typhoid bacillus). The water would also be improved considerably, as judged by physical and chemical standards. The excess of lime (about .007 per cent.) would then have to be neutralized with 2,500 gallons of adequately stored water, which, according to all my experiments, would not contain any of the microbes of epidemic water-borne disease. Thus 75 per cent. of the water would be sterilized chemically, and the remaining 25 per cent. by nature's own method of sterilization (storage). The mixture would have lost about 75 per cent. of its total hardness, and would contain no undesirable excess of free lime, besides being perfectly innocuous. Rapid filtration alone would then be required to remove the precipitate of inert carbonate of lime, and to bring the water up to a reasonable standard of chemical purity.

The system would be more expensive—in fact, doubly so—than sand filtration, but it would have certain distinct advantages, notably, its adaptability, its special suitability for flood waters, the saving in soap, the capacity to render quickly an initially foul water absolutely safe, the postponement of the construction of new storage reservoirs, and the raising of the purity of the metropolitan water supply to a pitch of perfection never before attained.

TUNNEL UNDER COLORADO RIVER.

The task of boring a tunnel under the Colorado River has been accomplished. Reports received by the United States Reclamation Service announce that the top drift of the Yuma tunnel penetrated the California bank on May 3rd, making connection with the shaft on that side, and completing the crossing of the stream. This tunnel, or siphon, is one of the most dangerous and difficult engineering structures undertaken by the Reclamation Service. It is one of the features of the Yuma irrigation project, which will reclaim 100,000 acres of the arid lands in the delta of the Colorado, known as the American Nile. It will carry water from the main canal on the California side to the Arizona canal system.

The great siphon will be 1,000 feet long, with an internal diameter of fifteen feet. It crosses the turbulent Colorado River 100 feet below the surface of the stream, and penetrates for the entire distance a soft and pervious sandstone formation. Its construction required the use of compressed air methods similar to those employed on the Hudson River tubes.

THE LITTLE SALMON RIVER VIADUCT. NATIONAL TRANSCONTINENTAL RAILWAY.

In recent issues of *The Canadian Engineer* there was described the new Red River bridge for the National Transcontinental Railway. This bridge includes a bascule span

Fig. 1.—General View of Viaduct.

and is a most interesting structure. The Little Salmon River viaduct for the National Transcontinental affords another interesting example of bridge work on the new railway. Mr. R. F. Uniacke, the bridge engineer for the Transcontinental, has described the structure very fully in a paper before the Canadian Society of Civil Engineers. An abstract of the description is given below:

The Act of Parliament, authorizing the construction of the eastern division of the National Transcontinental Railway, provides for a location from its eastern terminus (Moncton) through the central part of the province of New

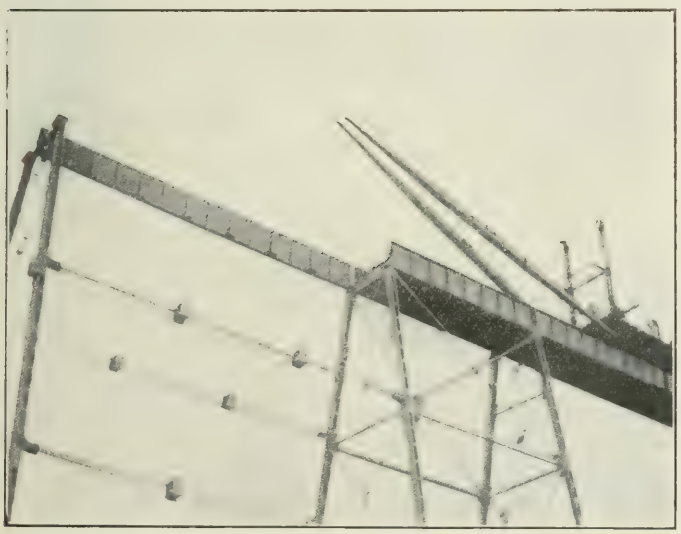


Fig. 2.—100-Foot Girder in Place.

Brunswick, and through the province of Quebec by the shortest available route to the city of Quebec.

The engineers of the Transcontinental Railway had located two lines, one known as the River route, following the St. John River, north from Fredericton, and the other the Central route; the latter was adopted as fulfilling more closely the provisions of the Act. That a line of railway has now been constructed along this route having a ruling point four compensated grade, with a maximum curvature of six degrees, is owing in a large measure to the advance in modern bridge and high viaduct construction. The valley of the Little Salmon River, 185 miles from Moncton, presented one of the obstacles to be overcome, as the grade development showed a crossing over 4,000 feet long, with a height of 200 feet above the water line.

The line approaches the west end of the structure with a six degree curve through a rock cutting and crosses on a tangent bearing N. 10°—27 ft. W., the grade rising 0.40 ft. per hundred. The layout consists of twenty-four towers 58 ft. 9 in. centres and twenty-five intermediate spans 100 ft. 3 in. c. to c., the end spans being 100 ft. 10½ in. centre of bent to outer end of steel; all the tower spans are alike and also the intermediate spans, except that the masonry ends are extended to give the required bearing. The towers and bracing are made alike as much as possible,

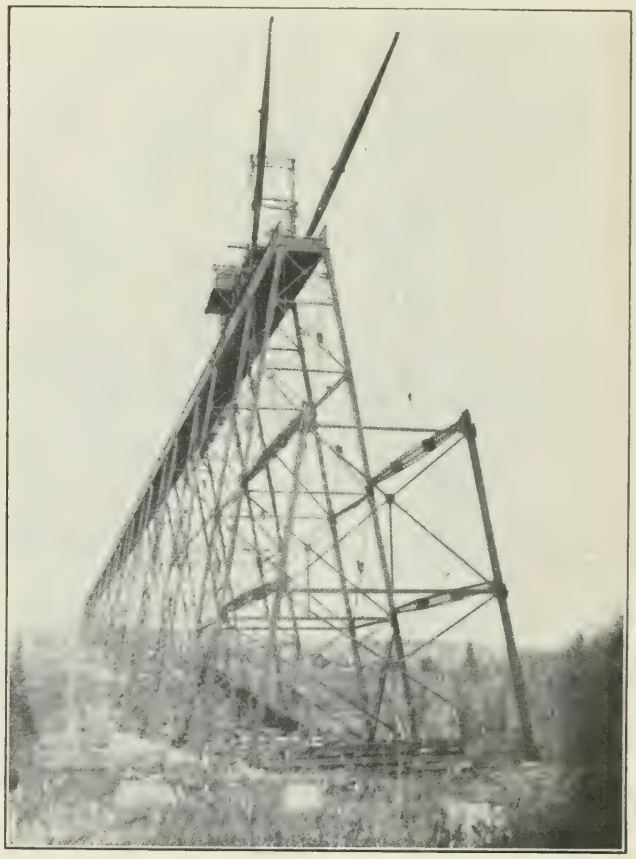


Fig. 3.—View of Erection.

necessitating one set of templates only for the spans and parts of towers which duplicate each other. A through girder system of construction was adopted, the girders being spaced 17 ft. 6 in. c. to c., while the floor beams with gussets were spaced 14 ft. c. to c., along the plate girders. The east end span is on a spiral to a 6 deg curve and in consequence the girders are deflected at this abutment 1 ft. 3 in. off the tangent to the structure produced. There were several reasons which led to the adoption of a through girder system. In high trestle construction where the use of falsework is out of the question, the most economical layout is that on an intermediate span as long as could be handled with a well designed traveller working from grade, so as to reduce the number of high towers, their pedestals and foundations. Spans of 60 ft. with 40 ft. towers are generally employed where deck girders are used, spaced 9 ft. c. to c., and bridge ties resting on the top flanges. Owing to the through girder system having a spacing of girders 17 ft. 6 in. c. to c., spans of 100 ft. are handled, since the bear-

ings of the traveller rest on the flanges, thus giving that much more base to brace the traveller in handling loads. The stability of the erection outfit is amply provided for so that in this case girders weighing 30 tons were placed in position. It certainly gives a feeling of safety to see from the car window the flanges of a heavy steel girder, and that this is not altogether sentiment is shown by the fact that instances of derailment are recorded, in which the car held to the roadway by the lateral resisting power of these girders.

The approach at the east end being through a rock cutting, in order to avoid building the steel work on a curve, and also to utilize the material in the cutting without waste, an abutment of reinforced concrete placed on top of the rock fill was decided on. A buried pier built from the original line at the banks of the river were built with curved cutwaters, the axis of piers being parallel to the direction of the current, forming suitable icebreakers. The anchor bolts for pedestals consisted of two rods, two inches in diameter, the lengths varying according to the up-lift to be resisted. These rods were anchored at the bottom by spacers of 10-in. channels and washers, the concrete being built around them. In order to give room for a little variation in their position, conical forms were set around each bolt, a lip being left at the top extending beyond the base plate of column through which these voids were filled with grout after the steel was erected. The west abutment or buried pier was about 40 ft. in height above the footing course, and in order to reduce the pressure on the soil and allow the embankment to run through and surround it, an arched void was left in a

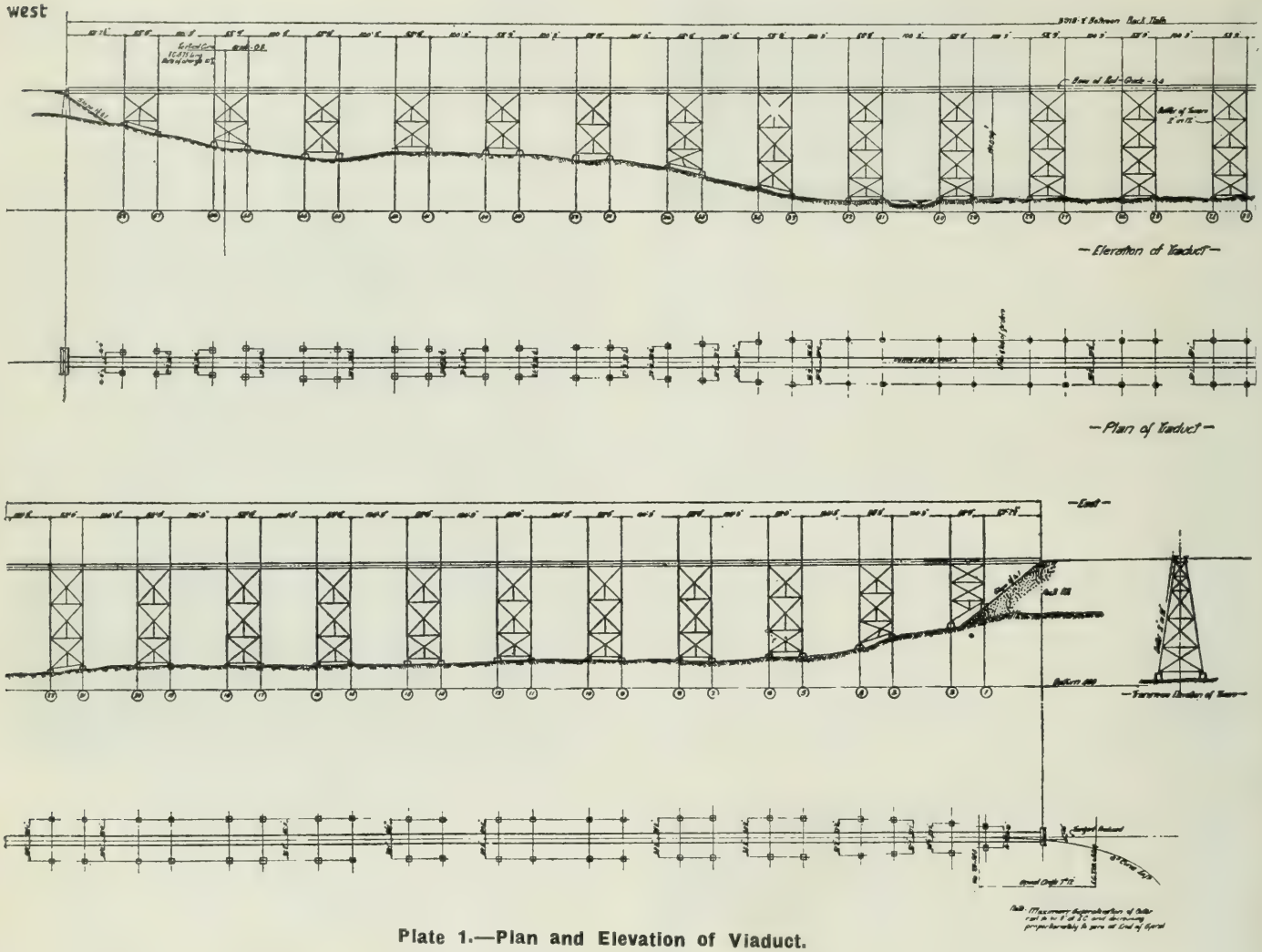


Plate 1.—Plan and Elevation of Viaduct.

surface at this point would have been over 100 ft. high, difficult to design and build, and very costly. This was avoided by the use of a bank abutment. The concrete was reinforced to prevent danger of cracks from settlement in the bank, and in order to give time for the bank to settle, the ends of the girders were temporarily supported by a cribwork of square timber, before building the permanent abutment.

In the design of the pedestals and west abutment, borings and test pits were first made to determine the character of the soil. This proved to be of compact sand, gravel and hard pan, so that no piling was required, the footings being designed to distribute the load at a pressure of from 2.5 to 4 tons per square foot. The four pedestals near the water

longitudinal direction. No difficulty was experienced in building to this design.

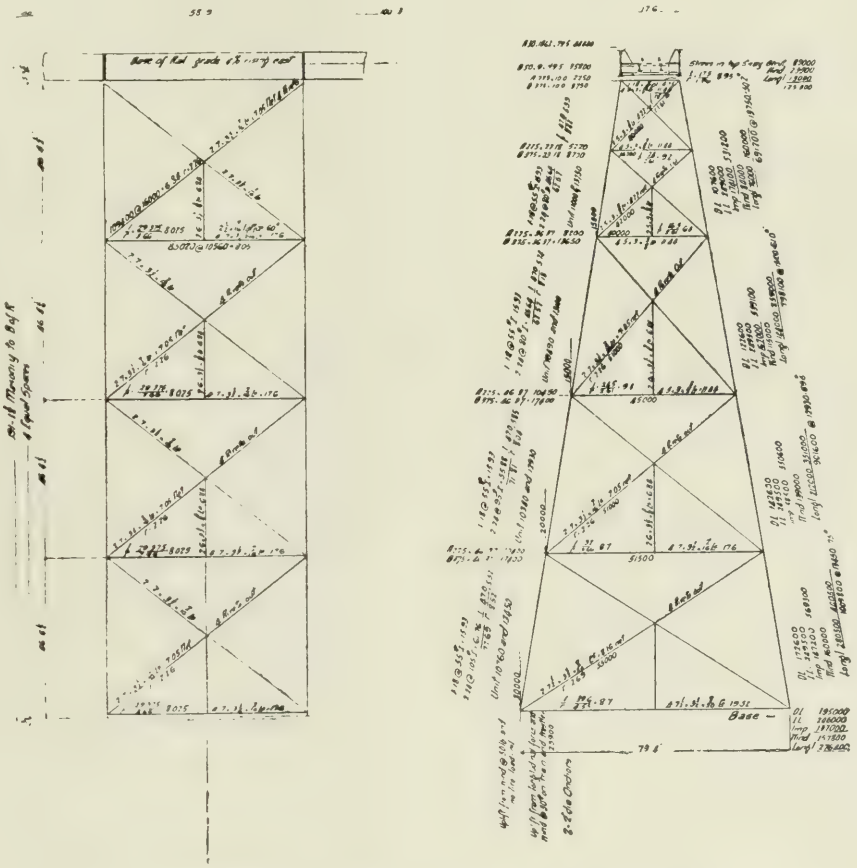
In laying out the work no triangulation was required and an ordinary steel tape was used, the writer's experience being that, as provision is made in the girders for expansion, a slight variation in the position of the anchor bolts is permissible, providing the expansion slots are made longer than the theoretical length requires. The chief difficulty consists in maintaining the anchors in a vertical position and protecting them from rough usage from swinging buckets of concrete and other causes.

The materials used in the concrete were international Portland cement, manufactured in Hull, Que., at present by the Canada Cement Company. The sand and gravel were

obtained on the bank of the river near the bridge site. In this locality good sand is very difficult to obtain, and, after a test of sand from several pits, the local material was selected, the sieve test showing after the gravel was screened out:—

Retained on	20	mesh	sieve	.....	64	per	cent.
" "	30	"	"	.....	17	"	"
" "	50	"	"	.....	15	"	"
" "	74	"	"	.....	2	"	"
" "	100	"	"	.....	2	"	"
					100%		

After treating the finer residue with a 20% solution of sulphuric acid, it was found to contain 6% of soluble matter, which was eliminated by thorough washing, and a mixture of one part cement, two parts sand, and four parts gravel, varying from the size of a pea to three inches was obtained. As the sand was not of the best quality, the use of 1:2:4 mixture was ordered in shafts of pedestals, since they have to sustain a high concentrated load on a comparatively small volume of concrete. The concrete used in the buried pier and foundations was a 1:3:5 mixture. In obtaining a proper facing mixture the coarser material was kept away from the forms by the use of perforated spades, pushed down and drawn back while the mixture was still plastic. This method was found more satisfactory than that of attempting to bond a facing mixture into the body as required in some specifications.



A Typical Bent on the Little Salmon River Viaduct.

The Dominion Government specifications were strictly adhered to in the proportioning of the members. The compression members were figured for the pin ended formula of these specifications. In the tension members of the towers a limiting length $\frac{l}{r}$ of 200 — was used to avoid sagging of members, to make them capable of resisting compression and to give initial stiffness. Attention is called to the use of bulb angles in the sway bracing of towers, which make a very stiff and economical section and avoid breakages in shipment. the great fault in box laced section of light angles. Traction and wind were figures as called for in the specifications.

The posts viewed from the stress sheets do not appear to be economical because of their relatively small radius of gyration when compared with a built up channel section; but the saving in weight of details and simplicity in shop work fully compensates for the extra main material. In the light of column tests it is reasonable to expect that the reduction in unit stresses for the increase of radii length would not be justified by practical tests. The metal is used mostly in directly resisting the primary stresses, as very little is required for secondary purposes (viz., lattice tie plates, etc.), and in this way a stronger column is obtained. The section used has also the advantage of continuous webs in each direction, which are greatly superior to the easily bent lattice bars, and moreover the interior of the column is much more accessible to the paint brush for shop and field coats. The section is symmetrical on both axes. having therefore its centre of gravity in the centre of the section, and no eccentric loading is induced from the girders. The small amount of redundant metal means uniformity of stress in the columns, and simplicity in the make up will decrease the cost of maintenance.

In calling for tenders for the steel work our usual practice was followed of furnishing bridge companies with a general design and details of girders and towers, together with a printed form of tender in which was filled in the estimated weights of steel, and number of feet B.M. of timber in the floor. With this system all bridge companies bid on the same basis, and are not required to make a single drawing to submit with tenders, but merely to fill in the unit prices for steel and timber erected in place, and to carry out the amounts on the estimated quantities furnished, viz., steel 14,000,000 lbs., timber 520,300 ft. B.M. After the tender is awarded the bridge company submit stress sheets and details for approval before ordering the material from the mills.

The rails were directly supported by 8-in. by 12-in. by 14-ft. bridge ties resting on the steel stringers, every fourth tie being 16 ft. long to support the plank footway placed outside the guard timber for the convenience and safety of the section men. An outside guard timber 8-in. by 9-in. dapped 1 in. over the ties, which were spaced four inches apart in the clear, the ties were secured to the stringers by ¾-in. hook bolts, and the guard timbers bolted through the tie with one ¾-in. bolt in every fourth tie. A steel guard rail 60 lbs to the yard will be placed inside the gauge line and eight inches therefrom in the clear, these guard rails coming together at the centre of the track one rail length beyond the end of the bridge and being protected by a cast steel point fitting the rail section and spiked to the road-bed ties.

Actual erection began July 27th, 1910; the steel was all assembled and last span swung February 8th, 1911, and all riveting and painting fully completed by August 19th, 1911.

The erection staff varied from 60 to 80 men, of which but six were employed on the big traveller, one sub-foreman and 14 men were used to assemble the steel work, and the rest formed from two to six gangs of riveters, also crew for derrick car used for unloading material in yard, and delivering same to traveller, and driver for light locomotive. The riveting gangs averaged 302 rivets per day of 10 hours per gang, a rate which would probably have been reduced by 50 per cent. if ordinary staging had been used, instead of the riveting cages.

One coat of Sherwin-Williams Black Metalastic paint was used in the shop, with a coat on each contact surface before assembling. Two field coats were applied, the first Metalastic brown, and the final coat Acheson Graphite. Rivet heads and shop marks were touched up before applying the field coats. The use of a different shade for the first field coat was a great help to the inspector, to enable him to see that the several coverings were properly applied.

In the final estimates the actual amounts and cost under the several items are:—

Substructure.

1,757	cu. yds.	1:2:4 concrete	@	$15.00
6,524	"	1:3:5 "	@	11.00
4,597	"	Excavation	@	1.00
10,534	"	"	@	2.50

Superstructure.

Steel	13,991,310 lbs	@ 4.68 cts. =	$654,793.31
Timber	518,041 ft. B.M.	@ 4.60 cts. =	23,829.89
			$678,623.20

Progress estimates were paid monthly on the superstructure according to the following basis:—

	Unit.	Rate.
Steel	100 lbs.	$ 4.68
Timber in floor	M.B.M.	46.00

Schedule for Monthly Estimates.

	Unit.	Rate.
Steel provided	100 lbs.	$ 2.00
manufactured	"	1.00
delivered at site	"	.40
assembled	"	.98
riveted	"	.15
painted and fully completed	"	.15
		$ 4.68
Timber delivered	M.B.M.	$40.00
framed and placed	"	6.00
		$46.00

The basis of payment was considered a fair and equitable distribution of cost throughout the different stages of manufacture. It is the result of experience on many bridges previously built by this and other bridge companies on the described method of working and specifications, and the writer believes may fairly be used in other similar cases, as proportionate cost data.

The work was carried out under the general direction of the writer from the bridge engineer's office in Ottawa, Mr. W. A. Duff, assistant bridge engineer, having charge of the general design and details. The Dominion Bridge Co., Limited, Montreal, were the contractors for the steel, which was efficiently carried out, Mr. F. P. Shearwood, C.E., having charge of the design for the bridge company.

The design and layout for the erection and the traveller were made under the direction of Mr. James Finley, superintendent of erection, who was responsible for the successful carrying out of the erection; also Mr. E. W. Nichols, foreman on erection.

The mill, shop, and erection inspection was satisfactorily carried out by the Canadian Inspection Company, Limited, Montreal.

The sub-structure was completed by Messrs. Powers & Brewer, sub-contractors under Willard Kitchen Co. The construction and laying out of this part of the work was performed under the direction of Mr. C. O. Foss, district engineer. Although the work was prosecuted in all seasons of the year there has been no accident or casuality of any kind.

A NEW PEAT MACHINE.

In the January issue of the Journal of the American Peat Society is a description of a peat digging machine which is in operation at Elizabethfehn in Oldenburg, Germany, designed by Dr. W. Wielandt.

Dr. W. Wielandt has designed a peat digging machine which is absolutely automatic in its working, so that much less hand work is required than formerly, and by its use the production of peat fuel has been reduced to a half or a third of its previous cost.

This machine, which is protected in the United States by Patent No. 996,898, and in Canada by No. 126,536, consists of a uniformly forward-moving truck or car operated on a portable tramway of 600 mm. (23.6 inches) gauge; from the side of the car is suspended a chain and bucket dredge 3 to 5 meters (10 to 16.5 feet) long and about 1 meter (3.28 feet) wide. On the same car is mounted a double-screw macerating machine, to which the raw peat is fed through a hopper that receives the peat as it falls from the buckets of the excavator. The macerating machine is provided with a mouthpiece of pentagonal cross section, and an automatic cutter which cuts the peat into bricks of uniform length as it is forced from the outlet. Coupled to the frame of the machine and moving forward simultaneously with it, is a belt conveyor which receives the bricks as they are cut off from the peat strand issuing from the mouthpiece. The conveyor automatically drops or lays out the peat bricks upon the whole width of the drying field as soon as the band reaches the end of its travel. The drying field may be from 12 to 30 meters (about 40 to 100 feet) in width.

The machine can be modified in its details to suit the conditions of the bog on which it is to be operated. It can be operated by an electric motor or by a gasoline engine, which may be placed on the car or on a special, independent truck, so as to be usable as a locomotive to draw the dry finished fuel from the drying field to storage sheds.

The standard machines will produce from 6 to 7 tons of air-dried peat bricks an hour, equivalent to about 40 or 50 cubic meters (52.3 to 65.4 cu. yds.) of raw material. The power required to operate the machinery is 20 horsepower. The cost in Germany for this type of machine, including the cutting device and brick conveyor, is from M. 12,000 to M. 14,000 ($2,400 to $2,800), which with duty of 47 per cent. and freight charges would make the cost, delivered in New York, from $5,000 to $5,200.

During 1911, three of these machines were in operation at Elizabethfenn, Oldenburg, the oldest one having been used for three summers, and, in the opinion of peat engineers who have tested them, they have shown the highest efficiency and economy.

The machine, when compared with others, has the following advantages: (1) Every individual process is absolutely automatic, so that only 2 or 3 workmen are required, as compared with 12 to 15 needed by older types of machines. (2) All movements of the machinery are continuous and uniform, hence its construction is simple and it is easy to operate. The utilization of the power is also uniform and in this way the wear and tear is reduced to a minimum.

(3) As the dredging covers only the width of one meter (3 ft. 3.4 inches), only the drier material on the face of the cuts is worked. This drier material, as shown by experience, contains about 12 to 15 per cent. of dry substance, as compared with but 5 to 10 per cent. contained in the underlying material. In other words, the peat obtained in this way contains materially less water when dug and macerated, and dries faster afterwards, than that produced by the

Peat Machine in Operation, Rear View.

old style machines. These facts make possible more frequent use of the drying field and also a more extended drying campaign.

(4) The light weight of the machine, about 2,500 kilogrammes (5,500 pounds) and the production of a sloping cut or bank, instead of a perpendicular one, permits the working of either fresh, undrained bogs, or of those which have been cut up by cracks caused by too rapid drainage. As there is no necessity for supporting the outer dredging boom, it is possible to dig the lower layers of peat from below the surface of the water.

(5) The dredging boom can be lowered or raised while the work is going on, without stopping the machine. The boom has a wide range of movement, which makes it fit to any slope of cut and depth of opening desired. In other words, the machine can be adjusted to any bog condition desirable and can be made to avoid any obstructions in the cuts, such as sand hills or tree stumps, without loss of time. If it is desired to remove the machine from one ditch to the other, it is only necessary to raise the dredging rig and swing it parallel to the long axis of the machine, when it is out of the way. This arrangement makes it possible also to move the machine easily on any track, turntable, switch, etc., of a portable tramway, without dismantling the machine or any part of it; therefore, the time required for such changes is reduced to a minimum.

(6) The machine proper, together with the brick conveyor, can be moved for considerable distances without difficulty, as it travels on a standard gauge 600 millimeter portable track.

(7) The deposition of the peat bricks on the drying field in a horizontal position, and their pentagonal form, favors the free run-off of any rain water which may fall on them and this lengthens the campaign about 50 per cent., or from 6 to 8 weeks, because the water does not soak into them. The three of these machines at work in Elizabethfehn during 1911, were operated during September, under such conditions. Peat machines of all other makes in that part of Germany were closed down at the end of July. From 25 to 30 per cent. more production, in effect, is gained by its use, from the fact that the time needed for moving and swinging this machine is reduced to a minimum, whereas, by the old systems, out of a possible 100 working days, only 60 to 70 could be utilized, as the rest were taken up in moving the machinery.

(8) The machine can be worked day and night, with electric light, so that the daily number of working hours can be increased to 20 instead of being limited to 10 or 12, as manual labor is practically excluded.

(9) As the buckets of the dredge work all depths of the bog simultaneously, a thorough mixing of the raw material is obtained and the result is a more uniform and even-textured product than that made by other styles of machines.

The cost of operation is as follows: A production of 6 tons of dry peat an hour, 15 hours a day, for 100 consecutive working days, is assumed; $6 \times 15 \times 100 = 9{,}000$ tons of air-dried peat for each machine for a working season. Three workmen to each machine at 8 marks ($1.60) a day each = 24 marks

	Marks.	Cents.
($4.80), or for a ton of air-dried fuel.....	0.26	5.2
Power required, 15 to 18 h.p. or daily about 200 kilowatt hours = 22 marks, or ($4.40) amounting for each ton of air-dried peat	0.24	4.8
Drying the bricks on a large scale, per ton, about	0.70	14.0
Materials and repairs, about.....	0.20	4.0
Supervision	0.20	4.0
Transportation of raw material for each 3 or 4 k.m.	0.40	8.0
Depreciation of 20 per cent. on machine and track	0.50	10.0
	2.24	44.8

or under 2.50 marks (50 cents) per ton of air-dried peat at the factory. This amount can be reduced if work is done day and night.

REFORESTING IN HASTINGS COUNTY.

As a result of the Act passed by the Ontario Government last year empowering municipalities to engage in forestry, the county of Hastings has already taken steps to acquire waste lands for the purpose of reforesting them. During the coming summer the Dominion Commission of Conservation will supervise a survey of the county of Haliburton and the northern portion of the county of Peterborough. This survey is to furnish a detailed description of economic and natural conditions and resources of the watershed in Peterborough and Haliburton counties feeding the Trent Canal waters and to serve as a basis for a system of management.

AN ENGINEER'S FINANCIAL RETURNS.

There is no good reason, says Mr. Chas. T. Main, president of the Boston Society of Civil Engineers, in a paper read before that body, why an engineer should not be as well paid as a lawyer or doctor. Mr. Main says:

A fellow-engineer said one day: "The hardest thing which I have to do is to make out a bill for services." It is here again that the natural modesty of the man is such that he is unable to appreciate the worth of his own services.

Some of us are called upon to make investigations and reports on enterprises involving the expenditure of millions of dollars, and the conclusion reached and the signature at the end of the report may prevent our clients from losing large amounts, or may cause them to embark in an enterprise which will net them great profits.

The concentrated knowledge and experience of years may be given in a short period, and yet we are apt to measure the value of our services on a per-diem basis, which will amount to a pitiable sum compared with the importance of the service rendered. This condition should be remedied so that the returns will be commensurate with the value of the services rendered. A lawyer of high standing, in making his charges, would consider not only the time required but the importance of the case or value of services rendered.

There is no good reason, aside from custom, why the engineer should not be as well recompensed for his services as is the doctor or the lawyer. The engineer engaged in the industrial development furnishes his services, as a rule, to a clientele that can afford to pay the full value for services rendered. Where a problem has been carefully studied, and the work carried out in accordance with the final conclusions, the result enables a saving in cost of production or an increase in profits. The engineer who works along these lines is carrying on the work of efficiency of which so much has been said and written recently. The industries can well afford to pay the cost of obtaining the benefits derived from good engineering.

In the regular pursuit of design and construction, there seems to be no way of charging more than some definite fixed sum or percentage, the aggregate of which cannot be large unless the undertaking is unusually large.

Many of our profession hold salaried offices, and the salaries are not very large as a rule; but the tendency of later years has been to make a better return for services rendered.

To the younger members the progress seems to be slow, but with ability and willingness to work there is no reason why success should not follow. Some of the greatest engineers have been men who have not had the advantages of technical training and have forged their way to the front by close application and native ability.

The young graduate from a technical school is apt to think he knows it all; and if he is well balancel he will soon find that he has laid a good and substantial foundation during his studies on which to build his education for effective work which will be of value to his employer, and which will develop from day to day in the actual performance of his work. If he is well grounded in the fundamental principles of the profession he will be able to undertake and carry out any work which is assigned to him; but he should have patience, and not expect too rapid advancement in position and salary.

For these reasons the younger men should be modest in their expectations and consider a part of their remuneration the valuable experience which they are acquiring.

After an engineer has had many years of experience and hard work, and his work and judgment are of great value to his clients, he should rise above his modesty and charge a sum commensurate with the value of his services. At the present time, however, it does not seem as if a large percentage of the profession could derive more than a good living from strictly professional work.

Some time ago one of my clients, who is very successful in manufacturing, said that his son thought he would like to be an engineer, and the father desired some advice as to the best thing for a boy to do. I told him that if he wanted the boy to make a lot of money, he should take him into business with him, but if he wanted him to have an honorable profession which would probably procure a living for him, but not much margin, to make an engineer of him.

FLAT SLAB BRIDGES.

By W. H. Finley, Asst. Chief Engineer Chicago and Northwestern Railway.

Since the introduction of concrete for the construction of railroad bridges no type of structure has met with more success than the flat slab bridge. In the days of stone masonry we were confined to the flat top culvert for openings up to four or five foot spans. Beyond that it was necessary to use the arch type. This meant increased expense in construction due to the cost of the cutting of the masonry for the arches. For years after the introduction of concrete it was a common practice to use, for small openings, say up to eight or nine feet, old railroad rails embedded in the concrete to form the top covering. In those days there was more or less second hand rail that could be used economically for this purpose and it was thought that in using the material in this way a cheap and satisfactory structure could be produced. It was soon discovered, however, that second-hand rails were not always available, and if available they could be put to better use than burying them in concrete for culvert construction. In spans greater than nine feet and up to thirty feet it was the practice, for a number of years, to use I Beams embedded in concrete. Among some engineers the idea to use beams of sufficient strength to carry the live load and consider the concrete only as taking the place of lateral bracing. This form of construction required very careful work in the field, inasmuch as it is difficult to make a satisfactory bond between concrete and large areas of metal, as represented by an I Beam, and with the greatest care in the selection of the material and the placing of the concrete it was difficult to prevent the same from cracking or separating from the beams. Although there were a number of satisfactory bridges built of this type, yet it was gradually abandoned. As confidence grew in reinforced concrete these smaller openings were built of the reinforced flat slab type. This type not only took the place of stone arches of corresponding span but also at a much less price. It enabled engineers to satisfactorily solve a great many problems in places where a wide and low opening was particularly desirable. The ideal structure from a railroad standpoint of use is that type that entails the least cost in maintenance. Stone masonry, however carefully constructed, required from time to time repointing to prevent the infiltration of water and consequent disintegration of the structure. With concrete properly constructed this maintenance charge is completely eliminated. Not only is the maintenance charge eliminated but the first cost of construction is considerably reduced. In the building of a flat slab bridge as a monolith it is possible to use less material in the side walls than would be required for an arch of corresponding span.

*Presented at the Eighth Annual Convention of the National Association of Cement Users, Philadelphia, Pa.

In railroad construction numerous instances occur where it is necessary to provide a wide and low opening and this condition is admirably met by the flat slab type of bridge. Before the introduction of this type of construction it would be necessary to provide an arch that would entail very much more expense than the flat slab bridge. Of recent years the flat slab bridge has been used to good advantage in cities where railroads were eliminating grade crossings by the elevation of their tracks. In the ordinary 66 ft. street where the city permits supports in the centre of the street and on the curb lines it is possible to use the flat slab type of bridge for spanning these openings. This results in a very economical form of construction as well as one that can be made aesthetically pleasing in general appearance. It also reduces to a minimum any maintenance expense. A steel structure for a similar opening requires painting every four or five years and if this work is not attended to the structure soon presents an unsightly appearance. This condition is very prominent in our elevated railroads in cities where the maintenance is not kept up.

Twenty years ago, in railroad construction, it was the universal practice to use, in openings from six to thirty feet, open deck I Beams. These were usually placed upon concrete or stone masonry abutments and presented as much difficulty in maintaining good track as much larger spans for the reason that the dump ties were just as troublesome to keep up as the same ties on a 150-ft. span. I know of no greater use for flat slab bridges than in the replacing of these upon open floor I Beam spans. It is usually possible to remove these I Beams and replace them with flat slab bridges, carrying the ballast across the bridge and making a uniform track surface. The I Beams can be used for other purposes or at least they have a salvage value that goes toward reducing the cost of the improvement. I have in mind a certain stretch of railroad of about thirty-six miles that has over twenty small openings from six to twenty-five feet made up with of I Beams with open floors. However carefully the track work was kept up it meant a bad riding track as each one of the bridges represented an unyielding space that was very noticeable to the travelling public.

There is no class of reinforced concrete construction, however, that is entitled to more careful and intelligent supervision in the construction of the same than flat slab bridge. When concrete began to displace stone masonry unfortunately the sole idea of constructing engineers was to see how cheaply they could build structures in concrete. Apparently many engineers were so anxious to prove the superiority of concrete in both cost and durability that they frequently sacrificed the latter for the former. It is generally recognized to-day that to produce satisfactory concrete construction it is necessary to use the utmost intelligence and care in the selection of the materials and the execution of the work. Unfortunately reinforced concrete construction has, in the past, been exploited from the commercial side rather than from the engineering. This, I think, was largely due to the various patented types of reinforcing material. Concerns marketing reinforcing material looked upon it from the commercial side only and furnished all sorts of information as to not only the good points of their particular shape or type of reinforcing but also formulæ and information as to the construction of reinforced concrete that would apparently enable any one, engineer or otherwise, to undertake the work of designing and building reinforced concrete structures. Happily, we are passing out of that stage of development and it is now being generally recognized that it is necessary to have engineers of experience and trained to correctly design any reinforced engineering structure.

POWERFUL FREIGHT LOCOMOTIVES.

Serious consideration given to railway economics has shown that specific locomotive design is a potent factor in operating expense reduction and it is to this fact that the difference in a fast passenger locomotive and a mountain freighter are due. In fact, the locomotive of to-day may be divided into many classes; each class calling for particular differences which have been developed and have proved that a locomotive designed for a certain class of work gives better results than one taken from another section of the line and applied to the same class of work.

Thus it is that the great wheat belt of Western Canada has called for a locomotive that will haul grain in that section to the best advantage, and the management of the Canadian Northern Railway have commissioned the Canada Foundry Company, Ltd., of Toronto, to construct twenty locomotives similar to the one forming the illustration to this article.

These monsters are among the largest locomotives operating in the Dominion, and differ, in the main, from smaller types only in their massive proportions and fuel-carrying facilities.

They are built for a standard gauge of 4 feet 8½ inches, and have a total wheel base (locomotive) of 25 feet 5 inches. The cylinders are of simple design. 24 in. by 32 in., and the boiler is of the extended wagon top with a working pressure of 180 pounds to the square inch; the boiler contains 272 two-inch tubes, while the smoke stack has a diameter of 17 inches.

When these machines were designed, the British Columbian Cabinet had not issued the edict that will compel all locomotives operating in that province to burn oil, hence, the fire grates of these locomotives have been designed to consume bituminous coal; but as they have been designed specially for wheat haulage in the prairie provinces, it is not likely that their fuel consuming facilities will have to be changed.

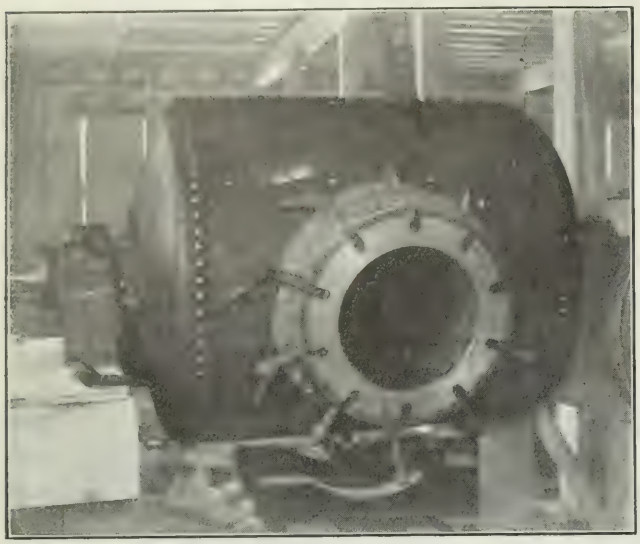
The driving wheels, of which there are six, have a diameter of sixty-three inches and a thickness of three and a half inches, the piston valves regulating the admission of steam to the cylinders have a diameter of twelve inches.

As may be readily seen from the cut, the design of the tender has been prepared in such a manner as to allow of exceedingly long haulages without stoppage for water or fuel; the water carrying capacity allows 6,000 imperial gallons to be taken at one time, together with ten tons of coal.

The total length of the engine and tender is about 65 ft.

THE HYDROLYSIS OF SAWDUST.

In a paper given recently to the Society of Chemical Industry, Professor W. P. Cohoe, of Toronto, gave an interesting resumé of his work on the hydrolysis of sawdust. The paper outlined briefly the history of the study of the reaction of various hydrolyzing materials on sawdust, beginning with the work of Bracconet in 1819. Most closely



View of Digester.

associated with the commercial study of this reaction are the names of Simonsen, Classen and Ewen and Tomlinson.

The work which the writer has done has extended over a period of two or three years, and although our attention has been chiefly confined to the action of hydrochloric acid upon sawdust, the action of many other acids has been studied.

The experimental work was conducted in three stages. In the first stage small scale laboratory experiments were made, in order to obtain in a general way the results which might be expected on a larger scale. In these experiments it was found that as high as 29 per cent. of the dry weight of the sawdust could be converted in a single operation into fermentable sugars. It was also found that by taking the material once treated and subjecting it to another operation, a further amount of this material could be converted also.

After having completed the small scale experiments, an apparatus was designed to enable the carrying out of experiments on a somewhat larger laboratory scale, under conditions more nearly approximating what would be the commercial conditions. On this scale it was found possible to treat about two pounds of sawdust at a time. On this scale the findings on the previous set of experiments were confirmed, and conditions necessary for a still larger scale anticipated.

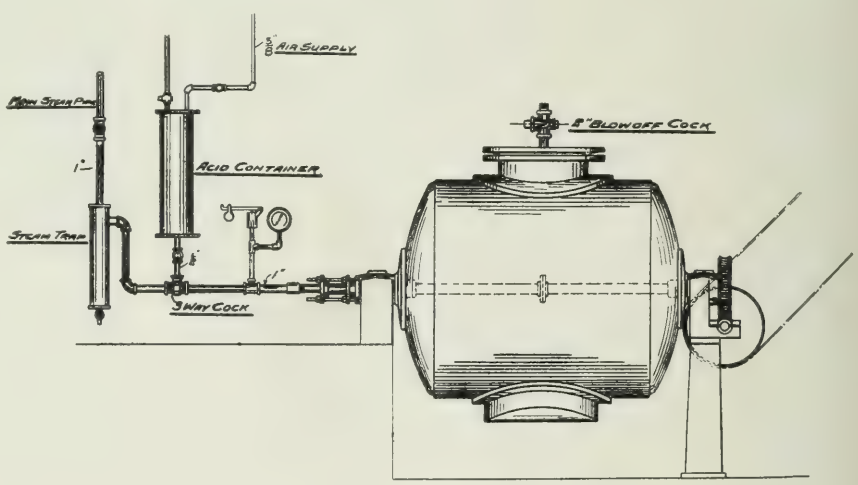
The third stage consisted of an operation on a semi-manufacturing scale. A digester was prepared capable of holding from eight to nine hundred pounds of ordinary sawdust. This was provided with a special lining, and also with the various necessary appliances for rotation and injection of steam and reacting materials, as shown in the accompanying diagram. The digester is filled when the manhole is in an upright position, after which it is closed. Steam is turned on, acting directly within the digester on the sawdust. The action of the live steam is to heat up the reacting mass inside, and to prepare it for the action of the reacting agent in the final stage. When the temperature and pressure conditions desired have been attained, the digester may be blown off in order to obtain any by-products which may have been formed. This part of the operation is known as the precook.

When the blow-off is complete the digester is again closed, steam is allowed to penetrate the mass, and with the steam is forced in the reacting agent. The action of the reacting agent is immediate, with the result that a certain percentage of the sawdust is converted into reducing sugars. The amount of this conversion depends on the temperature, pressure and percentage of acid present. We were successful in controlling these conditions to such an extent that the action hydrolysis was practically instantaneous, and it was only necessary to conduct the after cook for a sufficient length of time to insure a thorough mixing of the hydrolyzing agent with the contents of the digester. When blown off the sawdust has been converted into a golden brown color, resembling coffee grounds in appearance. This material may be extracted, and the extract, which contains glucose, may be fermented and subsequently distilled, in order to obtain alcohol, or, if it is thought desirable, the extract may be purified and clarified with the production of a pure white glucose sugar as the result.

The amount of the conversion which takes place from one operation varies from 20 to 40 per cent., depending upon the adjustment of the reacting phases. In no case, however, is all the converted material reducing sugars, as these are always accompanied by a certain percentage of what is probably intermediate materials.

As the result of our investigation several conclusions were reached which may be summarized as follows:

1. It is advantageous to have the sawdust heated up to the reaction temperature before introducing the acid.
2. A prolonged precook is not advantageous.
3. The recovery of valuable by-products, such as turpentine, is possible, using this method.
4. Coarse sawdust gives better results than fine.
5. By this method the time of conversion may be very much shortened over that consumed in existing methods, and consequently the output from a given plant may be very much increased.
6. Higher results have been obtained with hydrochloric acid than with other acids used by this method.
7. Commercial feasibility of the use of other acids.
8. Commercial advantage of double cook.



SKETCH OF DIGESTER.

Diagrammatic Sketch of Plant.

The Canadian Engineer

ESTABLISHED 1893.

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THE DEATH OF MR. GEORGE A. KEEFER.

It is with regret that we hear of the death of Mr. George A. Keefer. Mr. Keefer was one of the original members of the Canadian Society of Civil Engineers, and two years after its founding was elected as councillor. He served five different terms in that position, and did much to help guide the Society over the rough spots of its early life. He was one of the older men of the engineering profession in Canada, men who did so much in the early days to open up the country by surveys and railroad construction. During the past twelve years he was employed by the Dominion Government in British Columbia. Mr. Keefer's death will be regretted by the members of the Canadian Society of Civil Engineers, and the engineering profession generally.

CONTRIBUTED ARTICLES.

The reader demands several things of a technical journal. "Good Roads," in a recent editorial, expresses sentiments on this subject which appeal to us as worthy of reproduction. One thing the reader demands is that a journal shall supply him with the general news of the field which it covers; another, that it shall place before him authentic accounts of particular events, such, for instance, as conventions; another, that it furnish him with descriptions, more or less detailed, of large and important works. But if we correctly understand the wants of our readers, the articles of the most real use to them are the accounts of work such as they, themselves, are called upon to do, written by those who have done the work. Such articles, telling how some difficulty has been overcome, what the cost of some operation has been, what success has attended the employment of some particular method, or what failure has resulted from the following of some plan, give information of everyday use.

The engineer engaged in actual work is in an excellent position to obtain the requisite data for interesting and useful articles. His thorough familiarity with the work enables him to arrange his facts properly and present them in the form most helpful to others. When he has done this he can submit it to the journal of his choice and be sure of a fair return for his labor if the article is accepted. And if it describes actual work, giving methods and costs in sufficient detail, he can be reasonably sure that it will eventually be printed.

As we have already stated, no journal receives too much matter of this sort. There are several reasons for this. In the first place, the man on the job is too close to his work to quite realize its importance; because it is his daily work he is prone to think it of too little consequence to be of interest to anyone else. In the second place, he does not always realize that he has anything to gain by preparing a description of the work as a whole, or of some special phase of it. And again, even if he realizes that such a description might be a source of profit to himself and others, he is apt to feel that he hasn't the ability to write an article.

None of these reasons is valid. The work that a man is engaged upon may not be of any particular interest, taken as a whole, and yet it may be of unusual interest in some of its details. For example, there would seem to be little of general interest in the construction of a bridge abutment; yet if some original and ingenious method were employed to deposit the concrete below

water level, that detail would be worthy of note. Again, while the construction of an ordinary country road might not appear to be of any particular interest, yet if an especially efficient contractor's plant had been employed in its construction, a description of the equipment and of the way it was used would be of unquestioned value.

As regards the matter of personal profit, it is only necessary to remind the reader that all reputable publications pay for contributed articles when they are submitted on that basis. The compensation, though not apparently large, will often prove greater in proportion to the time required to earn it than the engineer's remuneration for his regular work. In addition to the money return, there is the benefit accruing to the writer from the publication of articles carrying his name.

The objection having the least weight of all is the average engineer's lack of confidence in his ability to "write an article." While a contribution should, of course, be prepared to the best of the author's ability, its literary excellence is its least important attribute. The matter for technical journals is judged chiefly by the facts and figures it gives, and if valuable data are presented the language in which they are set forth is of minor consequence. The publication has a staff whose duty it is to look after that matter, and if the article is otherwise available, its form will be attended to.

PULP LIMITS.

Ontario must be congratulated on the business-like manner in which they are disposing of their remaining pulp limits. Tenders for the Abitibi pulp limits, consisting of 1,560 square miles of pulpwood, will be advertised by the Government in a few days in accordance with the programme announced some time ago in the matter of development and colonization of the north country.

The successful tenderer must establish a pulp mill to cost not less than $500,000, to produce 100 tons of paper per day, to employ not less than 250 hands, and to run on an average of ten months in the year.

According to the conditions, $100,000 must be paid down the first year, $200,000 the second year, and the remainder, $200,000, the third year. It is stipulated that the pulpwood cannot be touched until $100,000 is spent. After the mill is operated continuously there must be an average output of 75 tons daily. The lessee must pay 40 cents a cord for spruce and 20 cents a cord for all other woods, subject to increases from time to time by Order-in-Council. The wood must be cut in such a manner as the Minister may direct, and it will be further agreed that no wood will be exported. The wood must all be used to supply the pulp mills. Failure to erect the mills within the specified time will entail a forfeiture of the bonus, etc.

The successful tenderer shall be entitled to obtain a lease of the Iroquois and Couchiching Falls on the Abitibi River, and the right to control the water on Abitibi Lake, subject to the stipulations that may be imposed by the Minister. Also, plans for water storage and water regulations must be approved by the Minister.

Other clauses in the conditions infer that the Crown reserves the right to erect dams or enlarge the dams of the pulp mills, to develop power to the fullest extent, and charge a fair and equitable sum for the benefits conferred, the rate to be fixed by the Hydro-Electric Commission.

The T. and N.O. Railway will be entitled to the delivery of all surplus power to the extent of 10,000 horse-power.

No doubt in the early future the railway will be electrified, for this has been the ultimate intention of the Government and its Commission for some time.

COST OF SURVEYS.

The following statement shows the average cost per mile of surveys executed by surveyors under daily pay and by surveyors under contract is taken from the annual report of the Topographical Branch of the Department of the Interior:

	Surveyed under daily pay.	Surveyed under contract.
Total mileage surveyed	3,962	13,927
Total cost	$388,600	$376,477
Average cost per mile	$98.08	$27.03

The high average cost per mile of $27.03 for contract surveys as compared with $17.97 for 1909 is due to the fact that all the townships subdivided during 1910 were wooded while of those subdivided in 1909, 169 were open prairie; the relative rates per mile for surveys in open prairie and in solid bush are as $7.50 to $31.

The average cost per mile for surveys performed under day pay increased from $49.33 in 1909 to $98.44 in 1910. The average per mile for block outline surveys was $175 as compared with $167 in 1909. When the party under Mr. B. J. Saunders, D.L.S., is omitted from the calculation the average cost per mile for block outline surveys is found to be about ten dollars per mile lower in 1910 than in 1909. Mr. Saunders was compelled to abandon the survey of the nineteenth base line west of the fourth meridian when only a few miles had been run, but after all the initial expenses of organization, travel, etc., had been incurred. Other factors to increase the average cost of the surveys in 1910 were the larger number of parties working in the foot-hills in Alberta and in the railway belt in British Columbia and the smaller number engaged upon miscellaneous surveys, resurveys and restoration surveys in other parts of Alberta and in Saskatchewan and Manitoba. Owing to the nature of the country surveys in the foot-hills and in British Columbia are much more difficult than in the level and settled districts, and consequently slower and much more expensive. The average cost per mile of surveys in the foot-hills in Alberta during 1910 was $79, and in British Columbia $85, while the cost in Saskatchewan and Manitoba and other parts of Alberta was $33 per mile.

COMPARATIVE RATES FOR CURRENT.

The following is a comparison of electric current rates in four of the cities of Southwestern Ontario:—

London—Dwellings, 5c. per kw., less 10 per cent.; no minimum rate. Business, same.

Guelph—10c. per kw., less 20 per cent. Business, same.

Berlin—5c. per 100 sq. ft.; 4c. per kw., less 10 per cent. Business, 12c. per kw. for first hour of installed capacity; 5c. per kw. for additional, less 10 per cent.

Woodstock—3c. per 100 sq. ft; 4c per kw., less 20 per cent. Business, 10c. per kw. for first hour of installed capacity; 4c. per kw. for additional, less 20 per cent.

PROPOSED PEACE MEMORIAL BRIDGE.

A student of modern political conditions is conversant with the fact that mankind in general is cultivating an abhorrence of war between nations and communities. Examples have not been few during the past decade when the voice of the people has ended pending hostilities and bloodshed by declaring, through the columns of the press and by other means, that war must not yet be, and if difficulties have arisen, arbitration must be given every possible opportunity to restore a peaceful attitude.

There are two pronounced reasons for this; first the national mental expansion which has kept pace with the unprecedented industrial expansion of the past few years, and secondly, the overwhelming expenditure of public money following a declaration of war between two or more nations.

It may be a coincidence or it may be the natural succession of events, nevertheless, it is a fact that the three nations who have not resorted to a force of arms for over ninety-eight years to settle international difficulties, are the foremost examples of mankind, speaking in general terms, among the nations; these three are Great Britain, France and the United States.

Prominent citizens of the first and last mentioned nations have assumed that was is over between these communities, and, acting upon this assumption, have made preliminary preparations for a tangible celebration when the ninety-eight years shall be increased by two.

The two illustrations show in which direction the plans for the event have turned; the erection of a permanent bridge across the Niagara River between Canada and the United States of America.

The Niagara River is an ideal spot for such a structure on account of the prominence enjoyed by the Falls, the ease of distributing the foundations equally and the possibility of welding into its members the idea that it is an indestructible link that shall bind these two nations together for all time to come. Just at what spot the structure is to be built has not been decided, but that it will be either crossing the river close to Lake Erie or just below the Falls is very probable.

Fig. 1.—Proposed Memorial Arch Bridge at Niagara Falls.

Mr. T. Kennard Thomson, acting as consulting engineer to a committee of prominent men of both nations, has prepared the illustrations which we present to our readers. Figure 1 is a proposed structure to be erected and take the place of the present steel arch bridge a few hundred feet from the Falls. It has a clear span of 840 feet with a clear height of 144 feet, and the materials are steel encased in masonry; the design of the structure, both mechanically and aesthetically, has been prepared with a view of one hundred years' use.

The history of the bridges at this point has been somewhat varied, the first was a suspension bridge with a width just sufficient to allow one wagon to cross at a time; the second was of such a width that two wagons could cross, but the structure met an untimely end and fell a prey to a miniature hurricane which swept the structure from its anchorage. The third was, like its predecessors, of the suspension type, and it was removed to make way for the present structure, which is now considered too light.

Figure 2 is an illustration of an alternative proposed bridge, and is of a much more pretentious nature, having a length of nearly 4,000 feet. The design of this bridge includes six main spans with a length of 300 feet clear each,

Fig. 2.—Proposed Alternative Memorial Bridge Between Buffalo, N.Y., and Fort Erie, Ont.

and a height of 90 feet. The materials prescribed for this structure are granite with concrete backing. The width of this bridge is 100 feet, but a suggestion has been made that the structure be erected at Niagara-on-the-Lake, and should this be adopted the width will be reduced by 50 per cent. A beautiful boulevard is now being constructed from Niagara Falls southward, and it is very probably that this will be used as a connecting ling in connection with this driveway somewhere in the neighborhood of Fort Erie and Buffalo. In the design of this bridge Mr. Thompson received the assistance of Messrs. Griffin and Wynkoof, architects.

Mr. Thomson, in addition to being the consulting engineer of the committee, is a member of the Committee of International Organization and the Commerce on Memorials. He is a Canadian and a graduate of the class of '86 of the School of Practical Science, now the Faculty of Applied Science and Engineering, University of Toronto.

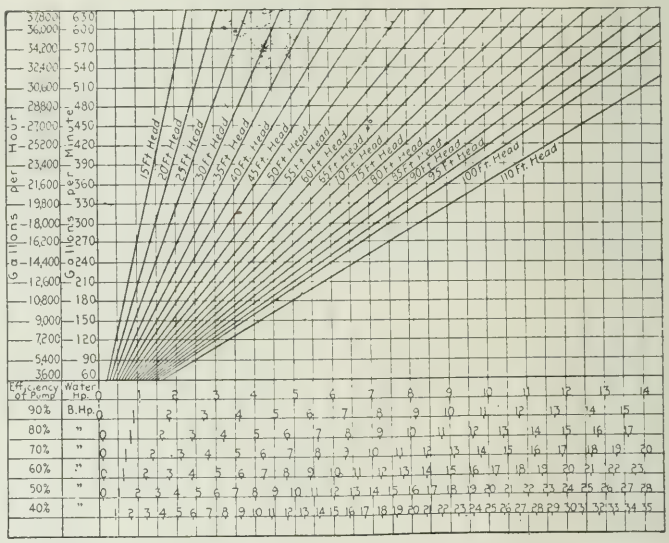
ASPHALT IN THE PAST YEAR.

Aside from its financial features, the annual report of the General Asphalt Company (owning the Barber, Trinidad and Bermudez Companies) issued May 14th, contains information of interest, especially to the paving and road-building industry. The total volume of business increased from $16,004,173.08 to $16,542,281.14. For the first time in the company's history the item "asphalt," which includes crude and refined asphalt and asphaltic products in all forms, exceeds the paving account. Sales of asphalt increased from 247,491 tons in 1910 to 265,677 tons in 1911. Thus while the consumption of asphalt increased in the amount just stated, and produced a revenue increase of $2,297,030, the paving done by the company shows a slight decrease, owing to the fact that a greater proportion of asphalt construction is done by customers of the company using Trinidad and Bermudez asphalts rather than by the company itself.

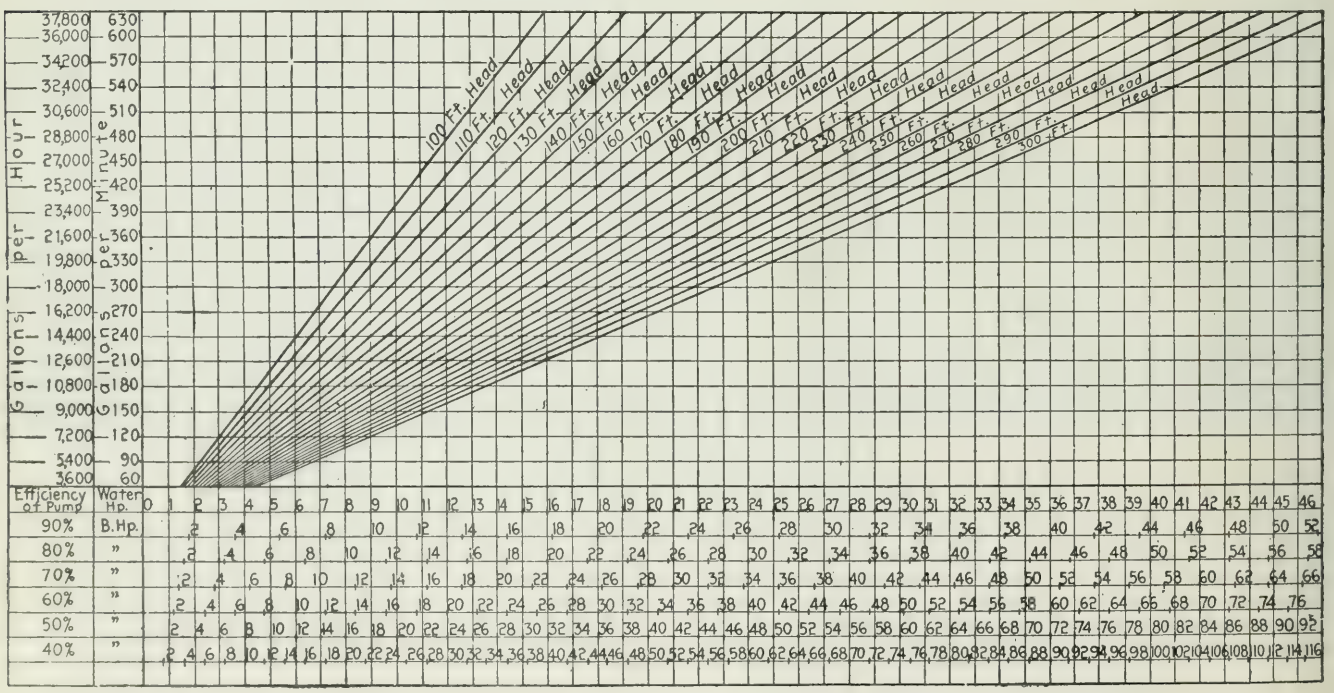
PUMPING DIAGRAMS.

The power required to pump a given quantity of water to a given height, when the efficiency of the pump is known, or how much water can be raised to a given height by the power available can be determined from the accompanying diagrams which were prepared by W. E. Wort for the American Machinist. These diagrams give the brake horse-power, number of U.S. gallons per minute and per hour, the pump efficiencies, and various heads in feet from 15 to 300 feet.

For example, if it is required to pump 350 gal. per min. against a total head of 85 ft. and the efficiency of the pump is 60 per cent., the brake horse-power is found by following the 350-gal. horizontal line to its intersection with the 85-ft. head diagonal, then following down the vertical line to its intersection with the 60 per cent. efficiency horzlontal line at the lower part of the table. It will be seen that 15 b.-h.p. is the power required for the duty specified.



Pumping Diagram, 15- to 110-ft. Head (U.S. Gallons).



Pumping Diagram, 100- to 300-ft. Head (U.S. Gallons).

THE HYDRAULIC RAM—ITS POSSIBILITIES OF DEVELOPMENT AND USE.*

By Stirling B. Hill.

The hydraulic ram was first invented by John Whitehurst, in 1772, and was made practical by Joseph M. De Montgolfer in 1796. The latter made the action of the waste valve automatic, thus changing the ram from a laboratory toy operated by hand, to a useful pumping device. Although the hydraulic ram was invented and used over 100 years ago, there was but little improvement in its design up to fifteen years ago.

To-day little is known of the hydraulic ram, even by engineers. The average engineer seems to have the most hazy idea of the characteristics of this much neglected pumping device. It is usually looked upon as a type of pump of small capacity and low efficiency, useful for pumping water for isolated dwellings, or where but a small quantity of water is needed and efficiency of no consequence.

Operation.—The essential features of a hydraulic ram are (See Fig. 1) supply or drive pipe A, ram chamber B, waste or impetus valve C, discharge or check valve D, air or equalizing tank E, and discharge or delivery pipe F.

The mere physical operation of the ram is simple, though the attendant phenomena and hydraulic principles involved seem to be but little understood. The general principle of operation is the same in all rams, however the mechanical workings and construction may differ.

Ignoring, for the present, the cause of the action, suppose the waste valve (C) to have just opened, the water in the drive pipe and ram being stationary, when the valve opens the water in the drive pipe starts to flow through the open valve, gaining in velocity, until the increasing velocity and pressure behind the valve are sufficient to close the latter. When the waste valve closes, the water flowing in the drive pipe with the momentum and energy of the moving column of water behind seeks another means of escape, which is secured by opening the discharge valve (D), flowing through the latter into the air chamber (E), and thence out through the delivery pipe (F). The air in the chamber acts as a cushion to the sudden inflow of water and maintains a nearly constant pressure in the chamber and steady flow through the delivery pipe.

The velocity gradually decreases until all the energy of the moving column of water is expended in forcing water into the air chamber and the flow ceases. The pressure in the air chamber then starts a back flow similar to the oscillation of water in a U tube. This instantly closes the check valve, thus retaining the water pumped. The tendency to back flow together with the sudden closing of the check valve, causes a momentary reduction of pressure in ram chamber (B), which allows the waste valve to open. The water then starts to escape as before and the cycle of operation is repeated. The action after once being started is automatic and the ram will continue to operate.

The back surge is usually sufficient to create for an instant a partial vacuum in the ram chamber. This condition may be taken advantage of, to introduce automatically into the upper part of the chamber a small amount of air at each stroke. During the waste period this air rises to the top of the chamber and at the delivery period is carried through with the flow into the air chamber. Thus the air supply is maintained, which otherwise would be gradually absorbed by the water under pressure.

* Abstract of paper read before the Pacific Northwest Society of Engineers.

Details of Operation.—The operation of the ram may be divided into two distinctive periods, namely, the acceleration or power accumulating period, and the retardation or pumping period. In the former, the waste valve is open and the water escaping through it, while the check valve is closed. In the latter, the waste valve is closed and the water is being delivered through the check valve.

In addition to the two periods mentioned there is the instant between the closure of the waste valve and the opening of the check valve, and also between the closing of the check valve and the opening of the waste valve. Each of these periods, though extremely short, has its distinctive functions and attendant phenomena.

We will now follow more in detail a cycle of operation or a stroke as it is commonly called.

When the waste valve opens the static column of water in the drive pipe, due to the inertia of its mass, cannot get up velocity at once, but is accelerated gradually. The time required to attain a certain velocity depending upon the ratio of supply head to length of drive pipe, or, stated in another way, upon the slope of the drive pipe. Neglecting the effect of friction, the acceleration is constant like that of gravity, and may be expressed in the familiar form $V = GT$, modified, of course, by the slope of the drive pipe, into $V = GT \frac{H}{L} = GT \sin A$, where A equals the angle of slope of the drive pipe, H equals the supply head and L the length of drive pipe. This is approximately correct for small velocities, but the friction varies as the square of the velocity, hence it soon becomes an element that must be considered. For any size pipe on a given slope there is a fixed possible maximum velocity. This is found by the Chezy formula $V = C\sqrt{RS}$ where S is the slope of the drive pipe, $\frac{H}{L}$.

Water Hammer.—Up to a certain point there is practically no resistance to the flow offered by the waste valve, as it will pass the water faster than it comes to it. After attaining a certain velocity, the water begins to head up behind the waste valve and when sufficient velocity and pressure are attained the waste valve is closed. When the valve starts to close the area of flow is further restricted, the pressure rises rapidly and the valve goes shut with a bang.

The sudden stopping of the moving column of water produces an instantaneous rise in pressure, causing what is called "Water Hammer." The intensity of the hammer is limited by the pressure against which the ram is pumping, as when this pressure is reached the discharge valve opens and prevents a further rise.

Experiments have shown that the maximum pressure in the ram exceeds that in the air tank by only a few pounds.

When the waste valve closes the lower filament of water is compressed, and is followed by each succeeding filament under like compression to the head of the drive pipe, while at the same time, the pipe walls due to this compression, are expanded. As this compression wave reaches the open end of the drive pipe, the first filament is relieved, then each in succession as a wave of rarefaction moves down the pipe. Thus the pressure waves race up and down ordinary pipe at a rate of about 4,000 ft. per sec. until worn out by friction.

The intensity of water hammer depends upon the velocity of flow and the rate of its suppression. If it is stopped instantly, the pressure developed is found by the formula, $P = \frac{vVW}{G}$ where P = water hammer pressure (in excess of static pressure) in pounds per square inch.

v = the velocity of wave motion in the pipe.
V = the extinguished velocity of the water.
W = weight of a cubic foot of water.
G = the acceleration due to gravity.

For ordinary conditions this would amount to about 60 lbs. for each foot of velocity extinguished.

Losses Involved in Ram Operation.—During the acceleration period the potential energy in the water supply entering the pipe is being changed into kinetic energy in the form of a moving mass of water, the power being accumulated and concentrated.

Without giving the matter consideration one naturally concludes that since water is running to waste, during the acceleration period, there must be a corresponding sacrifice of power and efficiency. This, however, is not the case, the only loss being the velocity head of discharge, which is usually but a fraction of a foot. The potential energy of this water has been stored in the form of kinetic energy in the moving mass of water in the drive pipe. When water power is used to raise water to a higher level it is self-evident that only a portion of the water can be raised to the higher level, hence, the remainder must be wasted at the lower level. For example, if a theoretically perfect machine were operating with a 10-ft. supply head and lift of 20 ft. ft. above the machine, it is evident that it would require two units of water with 10-ft. head to raise one unit 20 ft. The other unit is running to waste, yet no power whatever would be sacrificed, the machine in that case being 100 per cent. efficient.

The losses involved during the acceleration period are due to entry head, friction in the drive pipe, and the velocity head of the wasting water with the friction of its passage through the waste valve. These are all losses which can be determined definitely, hence the efficiency of the acceleration period is susceptible of accurate calculation when the co-efficients of friction for the design have been established.

In the case of the larger sized rams operating with medium drive head and moderate velocity the efficiency of the acceleration of power accumulating period may exceed 97 per cent.

The two periods of action are independent of each other, The action during the acceleration period is entirely independent of the conditions of delivery or retardation; that is, of the head against which the water is pumped. Likewise the retardation or pumping conditions are independent of the head used or time required in attaining a given velocity in the drive pipe.

The acceleration period ends when the waste valve is partially closed and the retardation period really commences before this valve is fully closed. The interval between this time and the opening of the check valve is really part of the retardation period though no water is pumped. The pressure is being raised in the ram accompanied by the water hammer effect.

A small amount of velocity is sacrificed in water hammer loss, the amount depending upon the head against which the water is pumped, or more directly the rise in pressure. The water pressure strikes the check valve suddenly and, due to its inertia, an increment of time is required to move it. This causes an instantaneous rise in pressure beyond that required to force the water through the valve and a small loss of efficiency is involved. The losses during the retardation period are: water hammer, opening discharge valve, friction through discharge valve, velocity head of discharge and slip of check valve at end of delivery.

Ram Capable of Mathematical Treatment.—Thus it will be seen that the action of the ram is capable of analysis and consequently of mathematical treatment.* When the various co-efficients have been determined by experiment for any given type of ram its performance under given conditions can be determined by calculation. The writer hopes later to acquire sufficient experimental data to be able to determine the proper value of the co-efficients.

Efficiency.—The efficiency of the ram is the product of the efficiency of the acceleration, or power accumulating period, and of the retardation, or pumping period.

There are two different formulas used for computing the efficiency of the hydraulic rams, namely, the D'Aubuisson and the Rankine formulas.

The former is expressed by the equation $E = \frac{q(H+h)}{(Q+q)H}$ and the latter by $E = \frac{qh}{QH}$ where:

E equals the efficiency of the ram.
Q equals the water wasted.
q equals the water pumped.
H equals the supply head.
h equals the pumping head above supply.

The D'Aubuisson formula represents the efficiency of the machine itself, as it considers all the water flowing through the drive pipe as the working force and the work done that of raising the water pumped from the ram to this point of delivery. If Q equals the total water supply and h the pumping head above the ram, then the formula takes the simpler form of $E = \frac{qh}{Qh}$.

The Rankine formula represents the useful work accomplished in raising the water from the level of the supply to the point of delivery.

The losses in the supply pipe are included with those in the machine itself in calculating the efficiency of the ram.

The efficiency of the ram depends upon the size of the machine and the conditions under which it is operating. The efficiency, under ordinary circumstances, of small rams varies from 50 per cent. to 70 per cent., and the larger sizes from 70 per cent. to 90 per cent.

With a properly designed ram, operating under favorable conditions, it is possible to obtain as high as 95 per cent. efficiency (D'Aubuisson).

Effect of Varying the Conditions of Operation.—Supply Head.—The effect of the supply head upon the operation of the ram is confined to the acceleration period. Other things being constant, the efficiency is increased by increasing the supply head. However, the same efficiency can be obtained with different heads by proportioning the velocity to the head.

With the higher heads, a greater velocity, with corresponding increase of capacity, can be used without sacrificing efficiency.

Consequently, the effect of increasing the supply head is to increase the capacity of economical operation, or, if the capacity remains constant, to increase the efficiency.

Pumping Head.—The effect of the pumping head is confined to the retardation, or pumping period.

Approximately the same efficiency during the retardation period can be obtained with any pumping head, but the velocity required to obtain this maximum efficiency increases with the pumping head. The efficiency, however, with

* Leroy Francis Harza, in his paper, "An Investigation of the Hydraulic Ram," published bc the University of Wisconsin, as Bulletin No. 205, gives a very complete mathematical treatment of the operation of the ram. He also carried out an elaborate series of experiments to check his theory.

which this higher velocity can be produced in the drive pipe will decrease; hence, the combined efficiency of the ram will decrease with an increase of pumping head.

If all other conditions remain constant, there is one pumping head for which the efficiency of the ram will be a maximum.

Length of Drive Pipes.—Other things remaining constant, the efficiency with which a given velocity can be produced in the drive pipe decreases as the length of drive pipe increases. This is due to pipe friction. The time required to attain a certain velocity with a given head increases as the length of drive pipe.

The efficiency during the retardation period is theoretically independent of the length of drive pipe. Practically, however, on account of the slip in the check valves and the loss in waste valve closure, it is not. The slip depends upon the frequency of the valve action, which, other things being fixed, depends upon the length of drive pipe. The longer the drive pipe, the fewer the strokes and less the slips.

The proportion of loss due to slip increases with the pumping head, both on account of the greater tendency to slip and the shortening of the delivery stroke. Therefore, a longer drive pipe is required for high heads than for low ones.

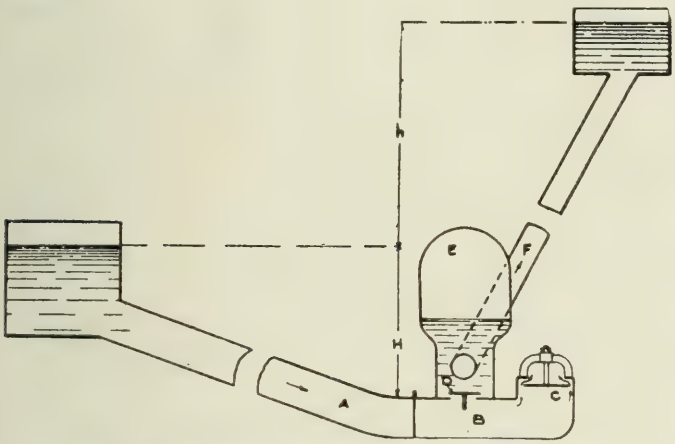


Fig. 1.—Essential Features of the Hydraulic Ram.

If the drive pipe is too long the friction is excessive, and if too short the slip is abnormal, hence there is for each size of ram with each combination of supply and delivery head a certain length of drive pipe that will produce the maximum efficiency.

There is also another working factor involved in the operation of the ram that has an influence on the minimum practical length of drive pipe. If the drive pipe is too short, or steep, the surging and vibration of the water column may interfere with the smooth operation of the valves, and the interfering waves will decrease the efficiency if the stroke is not carefully synchronized with the pressure vibrations. If too long a drive pipe is used, with the ordinary upward discharge, the automatic air supply will not work.

Size of Drive Pipe.—The main loss during the acceleration period is the pipe friction. During the retardation period the pipe friction is a minor loss. The efficiency of the ram will be increased by using the larger pipe, or a greater capacity will be secured with the same efficiency. The larger the size of the ram, with corresponding size of drive pipe, the greater the efficiency of the machine.

Strokes Per Minute.—Under any given conditions the capacity of the ram depends upon the velocity obtained in the drive pipe, and that depends upon the number of strokes per minute with which the machine is operating. The fewer the strokes, the greater the capacity, and the greater the number of strokes, the less the capacity.

A long, slow stroke allows the water to attain a greater velocity at each stroke and a corresponding greater average velocity, or flow through the pipe and ram.

For any given set of conditions there is a certain number of strokes that will produce the maximum efficiency. The efficiency increases with the number of strokes to a certain point, after which it decreases.

With a given supply head the efficient number of strokes increases with the pumping head to a maximum, and then decreases.

Limiting Factors.—The physical possibilities of the hydraulic ram are limited—first, by natural laws governing its operation, and, second, by human ingenuity in devising ways to make practical its possibilities.

Fundamental Limitations.—There seems to be no law law directly limiting the height of supply head that can be used, except that it must always be less than the lift above the ram. Let us, then, consider the pumping head. As stated before, the amount of pressure that can be developed by the sudden stoppage of water in the ordinary pipe is about 60 lbs. per sq. in. per second-foot of velocity stopped. Hence, the problem resolves itself into one of velocity obtainable in the drive pipe. In small pipes the limiting, or critical, velocity is soon reached. For example, a velocity of about 5.5 ft. only per second can be attained in a 1-in. pipe with a slope of 10 to 1, while in a 12-in. pipe with the same slope a maximum velocity of nearly 18 ft. per second could be attained. The practical operating velocity would probably be about two-thirds the maximum.

Thus it is apparent that, while a one-inch ram is limited to about a 400-ft. lift, under ordinary conditions, a 12-in. ram should be able to lift water at least 1,000 ft. The drive head that can be used must in each case be considerably less than the lift above the machine for practical operation. It is apparent that the fundamental limiting factors are beyond all practical requirements; hence, the problem resolves itself into one of practical design and mechanical construction.

Mechanical Limitations.—The design and operation of the waste valve seems to be the vital point. The ordinary hydraulic ram has an upwardly discharging waste valve of the disc type. The force of gravity—that is, the weight of the valve—is depended upon to open it and hold it open until it is forced shut, as previously described.

Machines of this type naturally have their limitations. Fifty feet seems to be the limit of the height of supply head that can be used. In the first place, the static head against which the valves will open is limited. They will not open with a long drive pipe or small ratio of heads. A moderate velocity will close them. For small rams, however, they answer very well. As the size of the disc valve increases, the area exposed to ram pressure increases as the square of the diameter, while the waterway around the circumference only as the first power. Thus the practical limit as to size is soon reached. This limit seems to be about 8 inches.

Certain manufacturers have lately cut the centres out of their discs and introduced light springs to assist the operation. This was quite an improvement, and they were enabled to increase the size of their machines, so that 12-in. rams may now be secured.

A Progressive Step.—Daniel W. Mead, now professor of Hydraulics at the University of Wisconsin, was the first to depart from the old rule-of-thumb design.

In 1895 he built and installed (under conditions that no ram manufacturer would attempt) a machine for the village of West Dundee, Illinois. In fact, no ram on the market today would operate under the same conditions.

This ram was installed with a 43-ft. drive head and 2,200 ft. of 10-in. cast-iron drive pipe. The makers assured Mr. Mead that such an installation was impossible, as the water hammer, due to stopping such a volume of water, would tear any machine to pieces. The ram was designed to suit the conditions; that is, with a large discharge valve area and with a very heavy spring to operate the waste valve, which was given a small movement. Needless to say, the machine operated successfully, and has continued to do so for the last 16 years.

The pressure in the ram exceeded that in the stand tower by about 2.5 lbs. There was no excessive hammer, as the column of water is not stopped or started suddenly, but gradually. This machine developed from 73 per cent. to 75 per cent. efficiency. This seems to be about the average efficiency of commercial rams in the larger sizes.

A New Type of Ram.—Last year the writer had occasion to investigate the subject of pumping machinery with a special view to the use of water power for its operation. The hydraulic ram, on account of its reasonable cost, automatic operation without the necessity of an attendant, low operating costs, durability and reliability, seemed particularly suited for use on irrigation projects, where conditions permit of its installation.

A particular case was presented to the writer some time ago for his consideration, where the supply head was so high that no ram obtainable would operate.

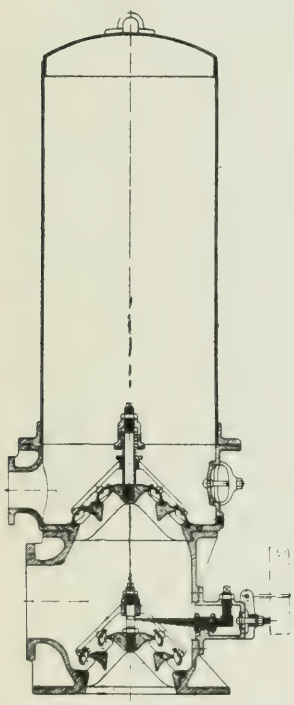


Fig. 2.—Section of 10-in. Sterling Ram.

After a careful study of the principles involved in the operation of rams, there appeared no fundamental reason why their operation should be limited to the narrow bounds of present practice. This being the case, it seemed that it should be possible to design a ram that would operate under a much wider range of conditions. With this idea in mind, a further investigation of existing makes of rams and their construction and operation was made.

It was apparent that a new type of waste valve was necessary in order to increase the strong, and have as large free capacity or field of operation of the ram. This valve must be so constructed as to eliminate the excessive hammer on its seat, must be light and strong and have as large free waterway as possible with a small movement of the valve.

The upward discharge was abandoned on account of the amount of head wasted on the larger sizes. The horizontal side discharge was considered, but passed because the machine would have to be submerged to above the valves to prevent their inhaling an excessive amount of air through the upper half of the valve during the fore part of the waste period. The solution seemed to lie in a balance valve of some description, having a downward discharge and operated with a heavy spring.

After numerous designs had been made and abandoned, a type of valve was finally evolved that seemed to fill the various requirements. This valve is composed of one or more concentric rings of increasing diameter, the number of rings depending upon the size of the machine. The plural rings are carried on a frame consisting of four radial arms, guided by a central stem, so they act as a single valve. The rings were changed from short cylindrical sections to ones having an arched cross section. See Fig. 2.

This allowed the water to escape over, as well as under, each ring when raised, thus nearly doubling the capacity of each ring with a given opening. This shape has the further advantage of offering smooth curved guides to the flow of the water and increasing the strength of the valve ring.

This arrangement of valves gives the greatest amount of clear waterway, with a minimum of weight of moving parts and space occupied, thus giving large capacity with high efficiency.

The valves being thin circular rings, with the vertical ram pressure practically balanced, they close very lightly, eliminating the excessive pounding. The hammer on the seats is the same in large rams, with this type of valves, as in the smaller ones, as they have practically the same shape and size of valve section.

A ram with valves of this type has been built and tested by Hill Bros. (See Fig. 2). It has a 10-in. supply pipe and a two-ring waste valve. The check valve is of similar construction, except that it has one ring and a central disc.

These valves, with a maximum movement of less than one inch, have an unobstructed opening nearly equal to the section of the supply pipe. The large efficient valve opening, with small movement of light valves, gives the machine large capacity without sacrificing efficiency.

The valve rings close on thick rubber seats consisting of a rubber ring inset in a dovetail groove in the metal seats. The rubber is forced into the groove and is just flush with the metal. This type of rubber seat cannot hammer to pieces as do other types of flat rubber packing seats having exposed edges.

The top of the valve ring closes flush with the outer edge of the valve seat above, the crack between being sealed with a rubber packing carried on the top of the valve. The valves are absolutely watertight, and constructed so they will remain so till the rubber disintegrates with age. The rubbers are easily renewed.

Test of 10-in. Sterling Ram.—The experimental machine was set up on the campus of the University of Washington, and a series of careful tests made under the supervision of the Department of Hydraulics. All measuring apparatus was carefully calibrated. A 50-ft. supply head was used and 140 ft. of 10-in. wrought-iron drive pipe.

The conditions were purposely made severe, the drive head being the highest yet used. The machine operated very satisfactorily, and the efficiencies developed were even better than anticipated. Various velocities were used, with lifts ranging from 100 ft. to 325 ft. The efficiencies ranged from 80 per cent, on the high lift, to 95 per cent. on the low (DeAubuisson formula). The drive pipe was too short to give the best results, especially on the higher lifts. Eight runs with a 115-ft. lift showed over 90 per cent. efficiency, the average being about 93.5 per cent.

It was hoped to secure a sufficient range of experiments to determine the characteristics and coefficients of the ram, but on account of the limited water supply available this proved impossible at the time. However, much valuable knowledge was obtained in regard to the fine points of ram operation.

A series of pressure indicator cards were secured on the ram, half way up the pipe and 20 ft. from the head of the drive pipe. These show the variations of pressure at these points. They seem to bear out the theory of the water hammer waves. The vibration in the drive pipe was very noticeable, especially near the head of the pipe, while in the ram

there was hardly any vibration. The indicator cards explain this. The ram cards show an almost constant pressure during the acceleration and retardation periods. The pressure rises very abruptly at the closure of the waste valve, but drops more gradually at the end of the delivery. The rise in pressure is almost instantaneous and scales less than 0.01 of a second in some cases. The closing of the check valve and the opening of the waste valve seems to consume from one-tenth to one-twentieth of a second of time.

Due to the throw of the indicator arm it was impossible to get a reliable record of the actual maximum pressure attained in the ram and drive pipe. In order to secure this data a special device was later made and used. It consisted of a small chamber on which the pressure gauge was mounted, a drain cock was provided in its bottom, and its connection to the ram, or pipe, was through a check valve and stop cock. The chamber contained air so that when the stop cock was opened the pressure vibrations pumped water into the chamber, compressing the air, the check valve preventing the return of the water. When the maximum pressure was reached in the chamber the water no longer was forced in. The gauge then indicated the maximum pressure.

The maximum pressure in the ram was found to exceed that in the air chamber from 3 to 4 lbs. After correcting for difference in the static head, the maximum pressure near the head of the drive pipe was found to be only 10 per cent. to 20 per cent. less than in the ram. The indicator cards show about the same result.

This shows that the stress in the drive pipe does not decrease uniformly from bottom to top, but is nearly constant the whole length. Consequently, the drive pipe should be designed practically full strength its entire length.

Possibilities.—Judging from the results of a careful study of the conditions involved, and observations of the operation of the ram described, it is believed the limits of the possibilities of operation and of capacity are beyond the ordinary requirements of practice.

Mr. Harza, at the conclusion of his paper, says: "If there is any reason whatever tending to limit the size and capacity of the hydraulic ram, it is the practical difficulties which might be encountered in the design of valves. It is believed that these are no more insurmountable than those encountered in the design of valves for other pumping engines of large size." It is believed that the proper valve required to solve the problem has been produced.

Head.—No difficulty should be encountered in operating these rams with supply heads from 1 ft. to 100 ft., and lifts from 5 ft. to 500 ft., the machines being designed to suit the service required.

In addition to the automatic hydraulic ram there is a current ram manufactured by the Lester Duplex Hydraulic Ram Co., of Portland, Ore. The waste valve in this machine is operated mechanically by a separate current wheel. The operating head for the ram is that produced by the velocity of the current of the ditch or stream in which the machine is set.

Capacity.—By the use of the multiple ring valve the size and capacity of the ram may be increased by adding more rings without changing any essential operating conditions. If the capacity is to be doubled, the length of valve ring, the unbalanced pressure on valves, the area of valve seats and the strength and resistance of the actuating spring are all increased in the same ratio. It is believed that rams having at least a 36-in. supply pipe can be built and operated successfully.

Uses.—The possible field of useful operation for the ram includes practically all those cases where water is to be pumped and local water power is available to furnish the power.

Water Works.—The ram is sometimes well adapted for pumping water for domestic supplies and city waterworks, as it operates continuously and efficiently without cost of attendance or power. Hydraulic rams in the past have been used mainly for supplying isolated dwellings and small villages. Now, however, the advent of this new type of ram makes these machines available for use in large city waterworks.

Irrigation.—There has been a great need in irrigation work for a cheap pumping machine that would work automatically, economically, and efficiently under all conditions, and having sufficient capacity to make them practical for large installations. Under some conditions the hydraulic ram is an ideal machine for the purpose. The new design makes possible the use of large units.

It operates automatically, no attendant being required. There are no bearings to oil and no moving parts exposed in the new design. It can be set up and operated miles from an attendant without housing or fear of molestation. It furnishes its own power without cost. The cost of maintenance is practically nil and the first cost of installation small. The machines are very flexible as to their operating conditions, the same machine operating equally well under a high or low head. The delivery head can be changed at any time without touching the machine or interfering with its continuous action.

The hydraulic ram could be included in the design of many gravity projects to advantage. Why construct the main gravity supply canal to the level of the highest land with the great additional length of canal and expense involved, when it is possible to locate the supply canal at an intermediate level using the power of the water dropped from the canal to the lower levels to raise the water to the higher levels? In many cases a great saving in cost could be made in this way and much difficult construction avoided.

On existing irrigation projects there are numerous cases where drops in canals and laterals can be used to operate rams to lift water to cover additional lands above the canals. In many instances the cost of the machines for this purpose would not exceed $3 to $10 per acre thus irrigated.

Mining.—The hydraulic ram is very well adapted for pumping water for mining operations. If there is water power available to do the work the ram is the cheapest and most economical pumping installation for the purpose. No fuel or power is needed, no attendant is required and there is practically no cost of operation. The rams will pump direct to the giant for hydraulic mining. Benches above the river bed could be economically sluiced by the use of these pumps to furnish the water required. It is often cheaper to install a ram for pumping than to construct a long gravity ditch, and much cheaper to maintain.

NEW METHOD OF UTILIZING HEAT FROM GASES.

Prof. W. A. Bone, F.R.S., Professor of Coal Gas and Fuel Industries at Leeds University, in a lecture at Leeds, described a new method of gas heating without flame, which, he believes, may work a revolution in fuel economy and have very important industrial effects.

Prof. Bone is one of the greatest living authorities on the subject of combustion. The new process has already been put into practical operation at Leeds. Hot surfaces promote the combustion of gases in contact with them, and it is on this property that the process is based.

AUXILIARY PLANT FOR POWER STATIONS.*

By A. H. Finch, M.A.

In this paper it is proposed to notice some of the points that should bear on the design of that part of a power installation which is referred to in general terms as the auxiliary system. In its widest sense, the term auxiliary might be taken to include everything except the principal agents involved in the cycle, which would mean practically everything except main engines, feed pumps and boilers.. More commonly the feed pumps are included as auxiliaries, which term will be taken to include also: (a) Thermodynamic appliances not essentially involving moving parts or power (e.g., economizers). (b) Apparatus requiring motive power independent of the main engines. Such a definition excludes transformers and certain small elements, such as oil pumps, which are often driven by the main engines.

The importance of this section of any large power plant is to be gauged by the proportion which it bears to the whole, whether in capital or running costs; figures are given subsequently which exhibit the ratio of auxiliary to main power in the case of some typical stations; but it presents a sufficiently accurate picture at this stage to say that in a modern power station of 30,000 kw. capacity the auxiliaries would account for 2,000 h.p., and probably £12,000.

To illustrate the divergence that can exist in the auxiliary equipment of a power station according to size and circumstances, it is only necessary to enumerate the apparatus employed. Thus it is possible to conceive of a station wherein the simplicity of the early marine engine is copied; where the boiler feed pump, air pump, and circulating pump are driven by levers from one of the main engine crossheads; a chimney produces all the requisite draft; ashes and coal are handled in all their stages by hand labor; and the exciter, if required at all is directly coupled to the generator shaft. Such a system, with the addition of a donkey feed pump or injector, is perfectly possible, and is approached, if not examplified, in many small stations. In fact, in non-condensing stations, a feed pump is the only really needful auxiliary. Its outstanding features are simplicity and thermodynamic waste.

In the opposite direction it is not unusual to find the following independently-driven pieces of apparatus: Exciters, feed pumps, air pumps, circulating pumps, exhaust (or other large) valves, cranes, ash hoists, coal hoists or conveyers, bilge pumps, boiler cleaning pumps, mechanical stokers, fans for induced draft, fans for generator ventilation, fans or pumps for cooling transformers, motor-operated switches, air exhausters for syphon circulating mains, air compressors for cleaning electrical apparatus, circulating water-straining appliances, economizer scrapers, oil pumps, and barring or engine-turning gear. Where what is known as a complete unit system is adopted, some of the above items are multiplied by the number of generators, resulting in an enormous aggregate installation.

Condensing Auxiliaries.

Assuming that for any condensing plant air and circulating pumps are required, it is of interest to consider the opportunity for simplification offered by the development during the last two or three years of rotary forms of air pumps. Whatever their merits or demerits as regards capacity for subduing air leakage on a system when contrasted with reciprocating pumps they possess two attractive attributes from the point of view of simplification in that (1) they occupy a very small space, and (2) they can be directly driven by any high-speed motive agent, whether electric motor or steam turbine. If it can be shown that they require no more maintenance than reciprocating pumps, which is reasonable to suppose from their exceedingly simple construction, a strong case for their adoption exists on these considerations alone. But where a complete use can be made of the exhaust steam, there is a further advantage in adopting a steam-turbine drive, as is shown in the following argument:—

Although such small turbines cannot be constructed to make any expansive use of steam below atmospheric pressure, by using the exhaust steam for feed heating advantage is at once secured even over a drive by electric motor. Let it be assumed that a small turbine is employed to drive on the same shaft the air pump circulating pump and water extraction or life pump attached to a main generating set. And for the sake of illustration let a plant of 3,000 kw. be considered. Then the power may be arrived at thus:—

Steam consumption, 42,000 lbs. per hour.

Circulating water, 65 times feed = 273,000 gallons per hour.

Head across circulating pump (for cooling tower conditions) 45 feet.

Power for circulating pump at 60% efficiency, 100 h.p.

Power for lift pump, dealing with condensed steam, and raising it 30 feet, with 50% efficiency, 1½h.p.

Power for air pump, 30 h.p.

Hence the power required for the combination is about 135 h.p.

At 35 lbs. per b.h.p. hour, the steam consumption of this auxiliary unit, exhausting at atmospheric pressure, is, therefore, 4,725 lbs. per hour. Such a quantity of steam would heat the feed water from 90 deg. to 200 deg. F. Thus the equivalent of $\frac{4725}{6.5}$ or 727 lbs. of coal per hour drives the circulating auxiliaries, and heats the feed 110 deg. F. The alternative, if electric drive be substituted for the small turbine, is 135 h.p. or 112 kw. at 3 lbs. = 336 lbs. coal for power, plus $\frac{4500}{6.5}$ = 692 lbs. of coal for feed heating. Total, 1,028 lbs. of coal as against 727.

Reciprocating air pumps are made with a high degree of efficiency, and may even take less power than the rotary type. But the power, small as it is in comparison with that of the main engine or turbine, is almost wholly dissipated in friction in reciprocating pumps, whereas it can be conserved in the form of heat in some forms of rotary pump, and where, as is the usual practice, separate motors or engines are used to drive the air and circulating pumps, the actual size of motor installed for a reciprocating air pump is settled by the consideration that a reserve of power must be provided in the motor, unless dangerously heavy fuses are used to deal with the case of flooded pumps, such as occurs after a stoppage (from any cause) while the prime mover is running. This means additional cost, and (in the case of induction motors) a bad power factor. No such reserve of power is necessary with a rotary pump. Consequently, the method of independent motors with reciprocating air pumps involves not only two motors instead of one, but that one of those motors should be larger than necessary. This arrangement, too, is likely to consume more energy than a single motor for the combination, and a fortiori more than the steam-turbine drive, if feed heating is placed to the credit of the latter.

* Abstract of paper read before the North-East Coast Institution of Engineers and Shipbuilders and printed in the "Transactions" of the institution.

It will be noticed that in the example given above, cooling tower conditions were assumed in calculating the power of the circulating pump. Their absence would have reduced the power for the pump from 100 h.p. to perhaps 60 h.p., depending on the location of the source of water. Natural-draft towers are responsible, therefore, for an appreciable increase in the motive power installation, and fan-draft towers for a considerable increase.

Economizers.

The question of economizers is almost entirely one of thermal efficiency. It is interesting, therefore, to note that they have been excluded from much important American practice. They are, on the other hand, used extensively in British and Continental work, though to very different degrees. Heating surface may be arranged for either in a boiler or outside it, with the qualifications that if in a boiler, it must be made of steel; but if outside, it can be made of cast-iron; and further, that gases cannot, in a boiler, be cooled below the temperature of saturated steam at working pressure, or in some cases superheated steam. In most designs of boiler these limitations result in a standard form, and a temperatutre of outgoing gases between 450 deg. and 600 deg. F. Such a standard form is accepted—and properly so—as being the outcome of the boiler-maker's experience; and the additional heating surface is arranged for apart from the limitation due to the presence of saturated or super-heated steam. But, while a certain uniformity is to be found in boiler surface provided for a given output, the number of economizer pipes may vary from nothing up to 12 per 1,000 lbs. evaporated. This variation in practice may be accounted for by the space available; but it is often influenced by consideration of the draft necessary.

Draft.

Draft may be created either by a fan or by a chimney. Where there are peculiar conditions such as the existence of long and tortuous flues, or the absolute necessity for drafts upwards of 1½ in., the question is settled automatically in favor of the mechanical method, practical considerations making it impossible to create a high draft by chimney alone. With a chimney the gases cannot be cooled below a certain temperature; otherwise insufficient draft will result. On the other hand, with a fan, gases may be cooled to any degree desired. Practical limitations are soon set in this direction by the space occupied by the economizer; and the result is that, though at first it might be expected that natural draft would necessarily be associated with smaller economizers than mechanical draft, in practice examples can be found of natural draft stations employing as large an economizer surface as even modern fan-draft installations. The mechanical arrangement has, however one advantage in facility of regulation independently of the weather, and in rendering a short chimney practicable.

The value of control over the draft cannot be assessed except in general terms by those who have had extended experience with both methods. Apart from this, the cost of power absorbed by the fans much outweighs the difference in capital charges due to a high natural-draft stack, as the following illustration, applicable to installations of about 10,000 kw. shows:—

For natural draft—	
Cost of chimney 250 feet high, with foundations	£3,000
For mechanical draft—	
Cost of chimney 100 feet high, with foundations	£1,200
Cost of fans and motors and extra flues.....	1,400
	£2,600
Balance of capital expenditure in favor of mechanical system	£ 400
Representing an annual charge, at 15%., of.....	£ 60
Against this is to be set running costs of motors, calculated on 200 h.p. for 5,000 hours at 0.25d. per unit	£ 780

The circumstances of load may, however, demand great elasticity in the steam-raising plant, in which case mechanical draft takes the place of additional boilers, and so may justify itself. Moreover, under normal conditions combustion is effected more economically with a high draft, if boiler and economizer surfaces are ample, less air of dilution being required per pound of coal.

The foregoing discussion is applicable only in cases where very moderate drafts are sufficient; and little variation is called for. The more usual case with an installation supplying power for general uses is that a certain latitude of draft is necessary for the purposes of the load, but the obstruction due to large economizers, coupled with the reduction at the chimney caused by lowering the temperature of the gases would result in insufficient difference of air pressure at the grate. In such cases the choice must be between natural draft with small economizer, or mechanical draft with large economizer; and the following treatment is put forward as being applicable.

The conditions assumed are as follows:—

Gases issue from boilers at.....	550° Fahr.
Air per lb. of coal, on average.....	23 lbs.
Temperature of atmosphere	60° Fahr.
Specific heat of products of combustion.....	0.25

In the case of fan draft, it is further assumed:—

Gases leave economizer and enter fan at..	320° Fahr.
Maximum water gauge required at fan.....	3 inches.
Usual water gauge required at fan.....	2 inches.
Efficiency of fan, 50% per cent. on average.	

In the case of chimney draft:—

Gases leave economizer at.....	450° Fahr.
Height of chimney	220 feet.

Then heat rejected from boiler per ton of coal fired is (2,240 × 24 × 0.25) × 490, or 6,585,600 B.T.U. In the case of chimney draft the economizer absorbs (2,240 × 24 × 0.25) × 100, or 1,344,000 B.T.U., and of this amount about 70 per cent., i.e., 940,800 B.T.U., is conveyed to the feed water, the balance being dissipated in flues, radiation and influx of cold air through economizer chain holes. In the case of fan draft, the power of the fan to create 3 in. water column, with an assumed efficiency of 50 per cent., may be found to be 16.6 h.p. per ton of coal burned per hour.* The usual h.p. required is, therefore, 16.6 × ⅔, or 11 h.p. per ton of coal per hour. The number of B.T.U. required to produce this energy, by way of boiler, turbine, alternator, transformer, and motor, with a combined assumed efficiency of 10 per cent., is $\frac{2,545 \times 11}{0.1}$ or 280,000 B.T.U. The quantity of heat usefully absorbed by economizer is (2,240 × 24 × 0.25) × 230 × 0.7, or 2,170,000 B.T.U. Consequently, of the total heat rejected from the boilers per ton of coal burned per hour, viz., 6,585,600 B.T.U., the natural-draft

* Height of column of heated products of combustion equivalent to 3 inches water column = 306 feet. Maximum horse-power required, with efficiency of 50%—

$$\frac{306 \times 24 \times 2,240}{60 \times 33,000 \times 0.5} \text{ or } 16.6 \text{ h.p. per ton per hour.}$$

method, with small economizer, realizes 940,800 B.T.U., while the fan method, with large economizer, realizes 2,170,000; less power to fan 280,000 = 1,890,000 B.T.U., or about double. Thermodynamically, therefore, under the assumed conditions, there is a gain of over 3½ per cent., really due to the use of the large economizer which is made possible by mechanical draft.

Next, as to the relative cost of the arrangements. This will vary in every case, and no two opinions on the matter will be the same. On the basis of an evaporation of 60,000 lbs. steam per hour, or a combustion rate of 3.84 tons of coal per hour, the capital cost of a fan installation with economizer of 9.6 pipes per 1,000 lbs. evaporated per hour, and short chimney, will be found to be, roughly, the same as for a natural-draft installation with 220 feet chimney and economizer of four pipes per 1,000 lbs., viz., £1,800. Capital charges can, therefore, be left out of a comparison, which might take the following form:—

	Per 60,000 lbs. Steam per Hour.	
	Mechanical Draft. £	Natural Draft. £
Saving of heat expressed as coal at 8s. per ton, 12,000 B.T.U. per lb., and 80% efficiency of evaporation.....	774	336
Maintenance	180	108
Power reckoned for 5,000 hours at 0.25d..	255	16
	435	124
	£339	£212

showing an advantage, in the case of mechanical draft, of £127 per annum. To this saving, which will obviously be greater still with greater load factors and in districts where coal is dear, must be added, for whatever it is worth, the convenience of being able to control draft independently of atmospheric conditions, and to force it to a degree unattainable with any chimney. It may be argued that this proposition depends entirely upon the manner in which the capital expenditure is made up. In the example cited above, variation of 25 per cent. in calculating the capital cost made, so as to swell the mechanical cost and reduce the other, would just about make the final results equal. But even in that case there would remain the practical advantages indicated.

Cost of Auxiliary Power.

Of more importance is the objection that an increase of the cost of power from 0.25d. to 0.38d. would extinguish the saving altogether. And this leads us to enquire what is the cost of power for auxiliary purposes. For most calculations it may be taken as the cost at generator terminals, plus some addition for transformation if necessary; less wages, as these are practically unaffected by the small proportion of output used on the station. The cost thus resolves itself into coal repairs and capital charges on generating and transforming plant. Many stations can now produce energy at 3 lbs. of coal per unit—some, of course, for much less—but at that figure and 8s. per ton the coal cost is 0.13d. Capital charges, at 15 per cent. on £15 per kw. with load factor 40 per cent., amount to 0.154d., repairs to 0.02d., making a total charge, for auxiliary power, of 0.304d. The figures adopted here are liberal with respect to good modern practice, and the price of 0.25d. assumed in former calculations, if low, is not by any means unattainable. On the whole, it would seem that the deciding factor in settling the matter of draft is the nature of the load. In isolated cases such a question as ability of the ground to carry a high chimney might be important—or again, the quality of ease in removal might recommend a short chimney and fan.

Feed Pumps.

It is only by elasticity of definition that feed pumps can be regarded as apparatus to render a thermodynamic principle advantageous. Yet they do not fall naturally into any other subdivision, being rather one of the main organs for carrying out the cycle. The power station designer has here a wide choice, between steam and electrical drive, and between reciprocating and rotating pumps. The latter possess many of the advantages of rotary air pumps already discussed, and practicable forms have been evolved. Such pumps, in respect of minimum wear, absence of valves, elimination of shocks to feed pipes and check valves, inseparable from reciprocating pumps, are almost ideal for power station work.

If a rotary pump can be combined with the circulating auxiliaries already described, and the whole be driven by a turbine on one shaft, a peculiarly compact and economical piece of apparatus results. There are naturally drawbacks in giving effect to this idea: one is that it may be difficult to find one speed suited to four different rotating objects; to a circulating pump, which may possibly have to deal with seventy times as much water as the feed pump, or to an impeller drawing against 29 inches vacuum and one delivering against 250 lbs. pressure.

Though not necessarily dependent upon rotary feed pumps, the closed-cycle system, whereby the feed water is at no stage exposed to the atmosphere, is rendered so much more attractive by their use that it may be noticed here. The idea underlying its application is that by reducing or altogether eliminating the aeration of the feed much trouble with economizers, feed pipes and boiler shells may be prevented. Since the feed is at no stage exposed to view as a current, it cannot be measured by the ordinary methods, and where anything more accurate than a Venturi tube test is required, an alternative arrangement of pipes must be installed for diverting the feed to the test tanks or recorders. For this reason it cannot be heated at atmospheric pressure, and surface heaters are, therefore, necessary. Then some elasticity is required between the discharge of the extraction pump and the suction of the feed pump to meet the case of boilers not requiring, minute by minute, exactly the same quantity as the steam condensed. And again, make-up feed for wastage has to be provided for. There are two or three methods of meeting these points. The simplest, but also the crudest is to provide a relief valve on the feed discharge, and regulate the admission of make-up feed to the condenser by hand. A more elegant suggestion, due to Mr. Sargent, and shown in Fig. 1, is to provide a tank into which the extraction pump delivers, and from which the feed pump draws. The tank is furnished with an overflow to a main reserve tank below, and a float mechanism controlling a make-up feed valve from reserve tank to condenser. When there is a surplus of water discharged from the condenser it overflows to the reserve tank, and when there is a shortage the float valve opens the connection from reserve tank to condenser. In this manner the system is rendered absolutely automatic, while the external make-up for wastage can be introduced by a float-controlled valve in the reserve tank fixed at a suitable level. By introducing the external make-up at this stage it becomes completely de-aerated before reaching the feed pump. Some stand-by pumping plant might be required for the case of banked fires.

In Fig. 2 is shown an alternative suggestion, proposed by Mr. Fullagar, with a tank floating, as it were, between the two pumps, but no provision is made here for de-aerating the make-up feed.

(To be continued.)

PROCESSES OF PULPWOOD MANUFACTURE.

In Quebec, seven-tenths of the wood used for pulpwood was spruce, balsam fir made up 28 per cent., and the remainder consisted of small quantities of hemlock and poplar. Both Quebec and Nova Scotia cut the four species used for pulpwood in Canada. No hemlock was reported from Ontario, in which province 90 per cent. of the consumption was spruce and the remainder was balsam fir. Spruce made up four-fifths of the consumption in Nova Scotia, balsam being used for practically all the balance. New Brunswick used spruce only.

Nearly four-fifths, namely, 78 per cent., of the pulpwood manufactured in Canada in 1910 was manufactured by the mechanical process; the sulphite process produced one-fifth, and the remainder (2 per cent.) was manufactured by the soda process. Quebec made 63 per cent. of the total mechanical pulp in Canada—more than twice as much as did Ontario. Of sulphite pulp, Ontario produced the most, although Quebec was a close second. The latter province manufactured over three quarters of the pulp made by the soda process.

Spruce, as in former years, was the chief wood used in each process. Over two-thirds (68.8 per cent.) was used for mechanical pulp; over one-quarter (28.7 per cent.) was made into sulphite pulp, and the remaining 2.5 per cent. was manufactured by the soda process.

Balsam fir has not yet been used in the soda process and is used to almost the same extent with the two other processes. The mechanical process consumed some 53 per cent. of this wood, while 47 per cent. was manufactured by the sulphite process. Eighty-four per cent. of the hemlock was manufactured by the soda process, which is adapted for most species of wood. One sixth of the hemlock was used to make mechanical pulp.

The physical properties of poplar wood do not adapt it for grinding by the mechanical process, and practically no poplar was manufactured by this process during 1910. It was used in almost equal quantities by the other two classes of manufacturers. Ontario manufactured a little by the soda process; only ground pulp was made in Nova Scotia; while New Brunswick produced small quantities of both sulphite and soda pulp.

Pulp manufactured by the mechanical process forms a greater percentage of the total during 1910 than at any time in the past. In the United States the percentage of ground pulp used is decreasing. The cause of the increase this year in Canada is probably due to the interruption of manufacture by the sulphite mills of New Brunswick. Unlimited supply of clean water is a necessity in the manufacture of wood by the mechanical process. A species of wood is also required which has a long loose fibre, which will not lose its shape and texture in the grinding. For these reasons Quebec with its spruce and balsam fir tracts and numberless waterfalls is the province best adapted for mechanical pulp manufacture.

Spruce furnished 83.2 per cent. of the wood used for mechanical pulp, and balsam fir contributed 16.6 per cent., with small quantities of hemlock and poplar making up the balance. The average cord of wood reduced by the mechanical process in Canada during 1910 produced 1,908 pounds of pulp. This is 257 pounds more per cord than was produced last year, but such comparisons depend greatly on the relative condition of air-dryness of pulp. Slightly over half this amount of pulp is produced per cord of wood by either the sulphite or soda processes, but the quality of texture is much better. The paper used in the average newspaper of to-day is composed of about twenty-five per cent. of sulphite fibre and seventy-five per cent. of the ground wood fibre made by the mechanical process.

In British Columbia, experiments are being carried on with the sulphite process, and, in 1910, 440 cords of spruce were used in the manufacture of paper. Seventy per cent. of the wood used in the sulphite process was spruce, mostly from Ontario. Balsam fir furnished 29 per cent., about three-quarters of which was from Quebec, and the same province used 1,800 cords of poplar to make sulphite pulp. The average production of pulp for every cord of wood used in the sulphite process during 1910 was 997 pounds.

Canada has the distinction of having the oldest soda mill in America, although the process is, at present, not in general use, and is found in only a few small mills. The production by this process, however, will shortly be increased by the completion of a large new mill, for the manufacture of 'Kraft' paper from soda pulp.

The soda process was the principal method used in the reduction of hemlock. Small quantities of spruce and poplar were also used in 1910. Balsam fir, however, is not suited to this process. Of the total, spruce formed 71 per cent.; hemlock, 19 per cent., and poplar, 10 per cent.

Quebec manufactured over three quarters of the pulp made by the soda process; 17 per cent. of the soda pulp was from New Brunswick, and 1,100 cords of poplar consumed by this method in Ontario made up seven per cent. of the total.

The average amount of soda pulp produced per cord was 987 pounds, or 10 pounds less than by the sulphite process.

The annual consumption of pulpwood per mill in Canada, during 1910, was 11,735 cords, as compared with a consumption of 12,442 cords per mill in 1909. The largest mills are those in Ontario, which used an average of 14,037 cords per mill. The average consumption per mill in Quebec was 13,710 cords; in Nova Scotia, 4,934 cords, and in New Brunswick, 3,783 cords.

Canada's foreign trade in pulpwood and wood-pulp is growing greater. Unfortunately, the tendency is still to export wood in the raw form of pulpwood rather than in the manufactured form of wood-pulp. This is a direct loss to the country, for the increased value due to manufacture is given away. In 1910, for the first time, $49,000 worth of pulp was imported into Canada, four-fifths of which was from the United States.

Although pulpwood production was less in Canada during 1910 than during the year previous, exportations of wood-pulp were increased by 48,233 tons. Wood-pulp exportations amounted in 1910, to 69.3 per cent. of the total amount produced in Can da, whereas in 1909 it was only 63 per cent. Of the 328,977 tons of wood-pulp exported, 288,807 tons, or 87.8 per cent., was mechanical pulp, which is a little greater percentage than in 1909. Only 78 per cent. of the pulp manufactured in Canada was mechanically prepared. While the increase in export for 1910 consisted of mechanical pulp, 1,173 tons more of chemical pulp also were exported in 1910 than during 1909. The 40,170 tons of chemical pulp shipped made up 12.2 per cent. of the total export.

The average value per ton of the pulp exported in 1909 was $14.67 for the mechanical, and $36.35 for the chemical pulp. This is an increase over the 1909 price of 70 cents for the mechanical, and a decrease of $2.64 for the chemical pulp. The average price for all pulpwood exported was $17.31, or 14 cents less per ton than the previous year's price. The prices per ton paid to Canadian exporters by the different importing countries were as follows for mechanical pulp: United States, $16.09 (exactly the same as in 1909); United Kingdom, $15.78 ($5.52 more than in 1909); other countries, $10.35 (37 cents more than in 1909). For chemical pulp: United States, $36.32; United Kingdom, $41.60; other countries, $38.30.

During 1910, over three-quarters of the wood-pulp exported went to the United States. This country took 74.3 per cent. of the mechanical pulp, and over 99 per cent. of the chemical pulp exported from Canada in 1910. Except for an increase of 3,000 tons of mechanical pulp to small transatlantic countries, export to other countries decreased. The export of chemical pulp to the United Kingdom has declined from 7,519 tons in 1908, to 178 tons (not one-fortieth as much) in 1910. The mechanical pulp shipped to the British Isles also decreased by 16,407 tons during 1910. The United Kingdom received in 1909, 32.5 per cent. of the mechanical pulp exported from Canada while in 1910, only 21.5 per cent. of the amount exported was used in those countries.

BRITISH COLUMBIA'S COAL MINES.

British Columbia's production of coal, estimated at 2,435,000 long tons, is 365,000 tons less than that of 1910. Coke also shows a decrease of about 140,000 tons; the output in 1911 was only about 78,000 tons as compared with 218,000 tons in 1910. The coal was produced in the several districts in the following approximate proportions:—Vancouver Island, 1,785,000 tons; Nicola Valley and Similkameen, 225,000 tons; and South-East Kootenay, 425,000 tons. Practically all the coke was from the last-mentioned district. The effects of the strike of the coal-mine and coke-oven employees on the production of coal and coke in the Crowsnest District, South-east Kootenay, has already been mentioned; in quantities of products it brought about this position: there was a decrease (net) of 605,000 tons of coal and 140,000 tons of coke. As the net decrease for the whole province was 365,000 tons, it will be seen that in other districts the decrease from the Crowsnest collieries was in part offset by increases in other parts—in the output of Vancouver Island, Nicola Valley and Similkameen coal mines.

Of the average yearly value of the mineral production of the province for the last five years, the production derived from coal and coke has been about 35 per cent. of the whole, while for the year 1911 it was nearly 39 per cent., and this despite the decreased output of the Crowsnest mines. It is true that the output of the collieries for 1911 is considerably less than for 1910, but the year 1910 was the record year in the history of coal-mining in the province, with a production valued at $11,108,335. The output for 1911, with its total value of $8,987,500, in the proportion of $8,522,500 for coal and $465,000 for coke, is second only to that of 1910, and is greater than that of any other year.

No branch of the mining industry of British Columbia appears to have a better prospect for expansion and consequent enlargement of production than that of coal-mining. A gratifying feature in this connection is that the promise of extending operations and increasing the output is general, that it appears evident that all the coalfields in which there has already been production may be expected to show a steady increase in output. That this is so will be manifest if attention be turned to local conditions in these several fields.

Briefly reviewing these conditions it may be noted that recent progress has been general. On Vancouver Island, the Western Fuel Company made the largest production in 1911 it has ever made; not only so, but a new mine is being opened, which it is expected will commence production next autumn, and be rapidly developed to a producing capacity of 1,200 to 1,500 tons a day. At the mines of the Canadian Collieries (Dunsmuir), Limited, there is also evidence of much progress, especially at its Union colliery, in the Comox District, where a new shaft mine is being opened and hydro-electric power for use at the mines is being developed. Production returns for 1911 have not yet been received from the last-mentioned company. It is expected the output of coal in 1911 was not less than 900,000 long tons. The Pacific Coast Mines, Limited, increased the output from its Fiddick mine at South Wellington, and further developed its Suquash mine in the northern part of Vancouver Island. The Vancouver-Nanaimo Company also made headway, for it arranged to provide shipping facilities at tidewater and to add to its coal-mining plant.

In both the Nicola Valley and Similkameen Districts progress was also noticeable, additions having been made to the coal-mining plants, and the output of coal in 1911 was larger. The Nicola Valley Coal and Coke Company increased its output from 141,000 long tons in 1910 to about 190,000 tons in 1911, and enlarged its coal-handling plant to a capacity of 1,000 tons a day. Three other coal properties in the Nicola Valley also had development work done on them in preparation for mining coal on a commercial scale, though as yet their production remains comparatively small. Coal was reached by a long crosscut tunnel on the property of the Columbia Coal and Coke Company, situated between Granite Creek and Collins Gulch, in the Tulameen Valley, and the work of equipping this mine with plant and machinery is in progress, while railway transportation has already been provided. At Princeton, the Princeton Coal and Land Company has made arrangements with a coal-mining machinery firm to supply a tipple and other equipment, the handling capacity to be 500 tons of coal a day and the plant to be ready for use early in 1912.

In East Kootenay, apart from the suspension of production while the employees were on strike, there were interesting developments. The Crow's Nest Pass Coal Company opened three or four practically new mines at its Coal Creek colliery, and it is claimed that from these a comparatively large quantity of coal of excellent quality can be mined. This company also did some effective prospecting at its Carbonado colliery, where new seams were found, and the work done on some of the old seams led to the hope that mines can be opened there in ground where the rock-structure is more favorable to mining coal. At the Hosmer colliery, of the Hosmer Mines, Limited, another level has been made along the outcrop of the coal-seams, about 500 feet above the level of the main entry to the mine, and facilities have been provided for transportation of the coal down to the main incline and thence to the shipping tipple. At the Corbin Coal and Coke Company's colliery an enormous deposit of coal has been opened at the surface and preparations have been made to work this coal open-cast, literally like a quarry. This most unusual occurrence of coal is situated at an elevation of from 800 to 1,200 feet above the main entry to the mine, in which latter the body of coal is also of great size, having a maximum width of about 300 feet.

There was little change in the situation affecting the large coal areas of the upper Elk River region of the Crowsnest District, described in the annual report of this department for 1909, for railway transportation has not yet been provided, and until it shall have been there will not be any commercial production of coal in that part of the province.

Concerning coal in the Skeena country—here, too, there can be no production until after railway transportation shall have become available. Public attention has been directed to what is known as Groundhog Basin, where the occurrence of much anthracite coal is known. A press bulletin, issued recently by the Geological Survey of Canada, gives information relative to this field, as follows: "Considerable interest has been manifested during the past seas-

on in the Groundhog coal-basin, which lies at the head of Skeena River. Probably 600 square miles have been staked and several groups of capitalists are interested in the field. Mr. G. S. Malloch, of the Survey Department, who spent the summer investigating the southern end of the basin on behalf of the Geological Survey, furnishes the following notes on this new coalfield:—

"'The coal-measures so far as known have a northwestward extent of at least seventy miles, and a width at the southern end of thirty miles. The sediments have a thickness of upwards of 3,000 feet, but contain coal in commercial quantities near the top and bottom only, though there are a few thin seams in the intermediate beds. The upper horizon contains seven seams with thicknesses varying from 2 to 6 feet, and, so far as is known, is limited to an area of twenty square miles. The lower horizon contains at least three seams 4 to 6 feet thick, and extends over most of the area occupied by the coal-measures.

The coal is anthracite in character. Some of the seams are high in ash, but from one of them some excellent analyses have been obtained. The basin is faulted considerably, and there are numerous local flexures associated with the faults. The development of a coalfield of this character near the Pacific coast would be of great importance to British Columbia. It lies about ninety (nearer 140) miles from tidewater at Stewart, Portland Canal, along a possible route for a railway, and about 150 miles from Hazelton on the Grand Trunk Pacific railway.'"

On Graham Island of the Queen Charlotte group prospecting of the coal-measures was done, but no coal was mined for the market. A Vancouver company bored for oil on the west side of that island.

With the considerable growth of the Coast cities there has been a correspondingly increased demand for building-stone, brick, lime, cement, etc. Various quarries from which granite, sandstone, andesite, and other building-stones are obtained had considerable demands made upon them. No marble was quarried at Nootka, but the marble-quarry situated about eight miles from the head of Kootenay Lake was re-opened and marble again shipped from it. The Vancouver Portland Cement Company, with works on Vancouver Island, made much cement.

PERSONALS.

MR. H. W. D. ARMSTRONG has been appointed to the position of chief engineer on the Gibson and Minto Railway.

MR. P. S. WEISBROD has been appointed to the position of superintendent of the Canadian Pacific Railway at Moose Jaw, Sask. He was formerly trainmaster at Cranbrook, British Columbia.

MR. ANGUS SMITH has been appointed to the position of city engineer for the municipality of North Vancouver, B.C. For over two years Mr. Smith has held a similar position in Victoria of the same province.

MR. ALEXANDER B. MANSON has been appointed to the position of city engineer for the municipality of Stratford, Ont. For some time Mr. Manson has been superintending construction work for the Canadian Northern Railway near Gowganda Junction, Northern Ontario.

OBITUARY.

MR. GEORGE ALEXANDER KEEFER, according to report received from Victoria, B.C., is dead. Mr. Keefer was a well-known civil engineer and was district engineer of the Department of Public Works of Canada in British Columbia. He entered the government service in 1872, on the preliminary surveys for the C.P.R. and the Rocky Mountains. For a time afterwards he was engaged on general engineering work in Vancouver, but since May, 1900, has been with the Dominion Government. Mr. Keefer was 76 years of age.

MEETINGS.

The regular meetings of the Western Canada Railway Club was held in the city of Winnipeg on the evening of April 8th last. A paper on "The Passenger Department," read by Mr. W. P. Hinton, general passenger agent of the Grand Trunk Pacific Railway, formed the major portion of the evening's programme.

In the course of his address the speaker stated that the organization of a general passenger department may be comparatively simple as it is on a small line or very complex, but nevertheless firmly welded together and carefully shepherded, on a large line. The department proper may be divided into the following branches: Traffics, tickets, excursions; statistics and accounts; train schedule and equipment; advertising; tourist, immigration and colonization; baggage; dining, sleeping and parlor cars.

A detailed description of the various sub-departments followed and concluded the paper.

CANADIAN RAILWAY CLUB MEETING.

The regular monthly meeting of the Canadian Railway Club was held in the city of Montreal on April 9th last. The speaker of the evening was Mr. A. R. Roy, Ph.D., who addressed the gathering on the subject of "Swedish Steel."

In the course of his lecture the speaker first defined steel as an alloy of impure iron and carbon, and then led his audience to a consideration of why one steel with similar apparent analysis possessed different qualities, and stated that there were three answers to this question.

1st. Incorrect analysis, showing equality, when not equal, of the composing factors of the various steels.

2nd. More skillful manufacture. This includes the better experience and practise of the workmen, as well as higher excellence of apparatus and mechanical conditions, such as fuel, etc.

3rd. The undetected presence of enchancing factors or beneficial elements.

The latter possibility received the major portion of the consideration on the part of the speaker.

It is noticeable, he continued, that iron brought from Spain, the Urals, America, Germany, France and Sweden produces different qualities of steel, although the analysis, so far as is known, is exactly the same and all other conditions equal and identical. Yet there is a decided difference in the quality of the steels, for one will do better than another when put to work on the same piece of material, at the same rate of speed, and given the same depth of cut and an equal amount of lubrication. All the composing factors of the steel are supposed to be equal in proportion. Where is the undetected factor?

Steel is a complex alloy, not merely of Fe. & C. but of the complex combinations of Fe. & C. known as Ferite &

Cementite, and Silicon as a base. To this, other elements such as Vd, Wo, Ni, Ti, Mn, etc., are added. Of these only C. & S. are found pure and free in nature but all of the elements can be separated at a certain stage in the laboratory. Iron is never found pure in nature. Late discoveries have detected various foreign elements in combination with iron. Therefore, it must be in the iron that the difference lies. Especially as the phenomenon of variance is found only between the steels produced with irons of different localities. In proof of which experiments have shown that Swedish steel or steels made from a Swedish iron ore base, are able to do more and better work than any other kind of steel. We also know that the Swedish iron ore, in its natural state, is freer from the detrimental combinations of sulphur, phosphorus and nitrogen, etc., than any other ore found on the European continent or America. But even when these harmful elements were removed or reduced to the proportions found in Swedish iron ore, the quality of the steel, although greatly improved, was not found equal to the product compared with, that is Swedish steel.

The presence of varying quantities of vanadium was given as the main reason for the variances.

COMING MEETINGS.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—May 22nd-25th. Annual Convention at Chicago, Ill. Secy., D. B. Sebastian, La Salle St. station, Chicago.

FOURTH NATIONAL CONFERENCE ON CITY PLANNING.—May 27th-29th. Meeting, Public Library, Boston, Mass. Sec'y, Flavel Shurtleff, 19 Congress Street, Boston, Mass.

AMERICAN WATER WORKS ASSOCIATION.—June 3rd 8th. Annual Convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N.Y.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithica, N.Y.

ONTARIO MUNICIPAL ASSOCIATION —Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary. Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION —President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President, J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment. London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA —President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J.R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
5-25—Sanitary sewer, Islington, Ont.	(P. & S.)	5-16
5-29—Water works, sewerage and electric light systems, Melfort, Sask.	(P. & S.)	5-2
6-10—Electrical equipment, Vernon, B.C.	(S.)	5-16
6-3—Electric Generating Station Equipment, Bassano, Alta.	(S.)	5-16

(Bassano specifications also on file at the office of The Canadian Engineer, Montreal).

(Melfort plans and specifications are also on file at The Canadian Engineer Offices, 820 Union Bank Building, Winnipeg, and B33, Board of Trade Building, Montreal).

(Vernon specifications are on file at The Canadian Engineer Offices, Winnipeg and Montreal; Canadian Electrical News, Toronto; Contract Record, Toronto; Mather, Yuill & Company, Limited, Consulting Engineers, Vancouver, B.C.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Australia, steel rails and fish plates	May 29.	May 2.	60
Bassano, Alta., electric generating machinery	June 3.	May 16.	66
Fredericton, N.B., wharf	June 4.	May 16.	60
Hamilton, Ont., castings, meters, etc.	May 30.	May 2.	72
Hamilton, Ont., motors, turbine pumps, etc.	June 3.	May 16.	74
Islington, Ont., sewer	May 25.	May 16.	66
Lebret, Sask., school house	May 31.	Apr. 25.	61
Lunenburg, N.S., sewerage system	June 1.	May 9.	60
Melfort, Sask., waterworks, sewerage, etc.	May 29.	May 2.	72
Melfort, Sask., school building	May 29.	May 16.	60
Moose Jaw, Sask., water works fittings	May 30.	May 16.	74
Moose Jaw, Sask., retaining wall and sidewalks, Collegiate Institute	June 5.	May 16.	60
Ottawa, Ont., coaling stations	May 31.	May 9.	72
Ottawa, Ont., station and other buildings	May 31.	May 9.	74
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., fishing protection vessel	June 17.	Apr. 18.	74
Ottawa, Ont., design and construction of steamship	June 30.	May 16.	76
Owen Sound, Ont., wharf	June 4.	May 16.	60
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Quebec, Que., leasing of water-powers	June 26.	May 2.	72
Saskatoon, Sask., garbage incinerator	June 25.	May 2.	74
Sault Ste. Marie, Ont., sewerage works	May 27.	May 9.	76
Sault Ste. Marie, Ont., approach to wharf	June 4.	May 16.	60
Sault Ste. Marie, Ont., cement walks	May 27.	May 9.	76
St. Lazare, Man., bridge	May 24.	May 16.	60
Toronto, Ont., bridge	May 23.	May 9.	72
Toronto, Ont., bridge	May 25.	May 16.	72
Toronto, Ont., cast-iron pen-stocks	June 4.	May 9.	74
Toronto, Ont., storm overflow sewer	June 4.	May 16.	72
Trout Cove, N.S., breakwater	May 23.	May 9.	60
Upper Maugerville, N.B., wharf	May 23.	May 9.	60
Vancouver, B.C., bridging, grading, etc.	May 31.	May 9.	62
Vernon, B.C., electrical equipment	June 10.	May 16.	72

TENDERS.

Bassano, Alta.—Tenders for electric generating station equipment will be received until June 3rd, 1912. Specifications at the offices of The Canadian Engineer, Toronto and Montreal. (See advt. in The Canadian Engineer).

Belbeck, Sask.—Tenders will be received up to noon of May 23rd, 1912, for plans and specifications for the erection of a 40,000-bushel elevator for grading-in purposes at Belbeck. W. H. Beesley, Box 74, Belbeck, Sask.

Berlin, Ont.—Tenders for waterworks improvements at Berlin, Ont., will be received by the Water Commissioners. (See advt. in The Canadian Engineer).

Kenora, Ont.—Tenders for the erection of a fire hall in the town of Kenora, will be received up to noon of Friday, May 31st, 1912. Plans and specifications at the Town Office, Kenora, Ont. M. McCulloch, Clerk.

Montreal, Que.—Tenders will be received until June 1st, 1912, for the construction of a steel and cement bridge over Bevan's Creek, in the Township of Arundel, Argenteuil Co., P.Q.; length of span, 50 feet. Plans and specifications may be seen at the office of Cushing & Barrow, 112 St. James Street, Montreal, or at the office of the secretary-treasurer. Wm. Thompson, secretary-treasurer, municipality of Arundel, Quebec.

Montreal, Que.—Tenders will be received by the Board of Commissioners, City Hall, up to noon of May 28th, 1912, for the construction of sewers on the following streets:—

Beresford Street, from Rushbrooke to Wellington.
Western Avenue, from city limits eastwards.
St. Charles Street, from Dorchester Street to its limits.
Sterling Avenue, from Cote Ste. Catherine Road to its limits.
Madison Avenue, from Sherbrooke Street northwards.
Belgrave Avenue, from Canadian Pacific Railway to Sherbrooke Street.
De Repentigny Street, River St. Lawrence to its limits.
De Grosbois Street, from Azilda to De Repentigny.
Bellevue Street, from De Rocheblave, 250 feet eastwards.
Lebrun Avenue, River St. Lawrence to its limits.
Cadillac Street, from Montreal Terminal Railway, to 1,100 feet north of Sherbrooke Street.
Fortune Street, from Wellington to Favard Street.

Full information can be obtained in the office of the Engineer Superintendent of Sewers. L. N. Senecal, secretary, Board of Commissioners, City Hall, Montreal.

Montreal, Que.—Tenders for the supply and delivery of granite and artificial paving blocks, will be received by the Board of Commissioners, City Hall, until noon of May 29th, 1912. Specifications, etc., may be obtained from the Sales & Purchasing Agent, City Hall. L. N. Senecal, secretary, Office of the Board of Commissioners, City Hall, Montreal.

Moose Jaw, Sask.—Tenders will be received until May 27th, 1912, for the laying of approximately 6,700 feet of 12-inch cast-iron pipe. Plans and specifications may be obtained from J. Antonisen, City Engineer. A. W. Maybery, L. W. Rundlett, W. F. Heal, City Commissioners, Moose Jaw.

Moose Jaw, Sask.—Tenders for cast-iron pipe and specials, will be received up to noon of June 1st, 1912, by the City Commissioners. (See advt. in The Canadian Engineer).

Moose Jaw, Sask.—Tenders will be received by the City Commissioners up to noon of June 1st, 1912, for the supply and delivery of valves and hydrants, f.o.b. cars, Moose Jaw. (See advt. in The Canadian Engineer).

Moose Jaw, Sask.—Tenders for the delivery f.o.b. cars, Moose Jaw, of sewer pipe and specials, will be received by the City Commissioners up to noon June 1st, 1912. (See advt. in The Canadian Engineer).

Ottawa, Ont.—Tenders for dredging Toronto Harbor, Ont., will be received until June 4th, 1912. Combined specification and form of tender can be obtained on application to R. C. Desrochers, secretary, Department of Public Works, Ottawa. (See advt. in The Canadian Engineer).

Ottawa, Ont.—Tenders for the construction of a pile wharf at Edmonton, Alta., will be received until June 17th, 1912. Plans, etc., at the offices of F. G. Goodspeed, Esq., District Engineer, Emonton, Alta. L. B. Elliott, Esq., Acting District Engineer, Calgary, Alta., and at the office of R. C. Desrochers, secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—The Department of Public Works, Ottawa, is open to receive tenders for the supply of sorting cases for post offices, until May 30th, 1912. Plans, etc., to be seen on application to Mr. T. A. Hastings, Clerk of Works, Postal Station "F", Toronto and at the Department of Public Works, Ottawa.

Port Arthur, Ont.—Tenders will be called for shortly for the Sailors' Institute. Estimated cost, $30,000. Mr. Potter, Upper Canada Tract Society, Toronto, superintendent; F. Urry, Port Arthur, architect.

Regina, Sask.—Tenders for all of the works required and necessary in connection with the erection and completion of Westminster Church, Regina, will be received until May 27th, 1912. Plans and specifications may be seen at the office of N. R. Darrach, architect, Western Trust Building, city. J. J. McRae, Secretary, Building Committee, Box 455, Regina, Sask.

Regina, Sask.—Tenders will be received up to Tuesday, May 28th, 1912, for the construction of the following reinforcing concrete bridge work:—

Group 1.

(a) Two reinforced concrete bridge abutments for a bridge west of Lumsden.

(b) Two reinforced concrete bridge abutments for a bridge south of Estevan.

(c) Two reinforced concrete bridge abutments and a small reinforced concrete bridge south of Drinkwater.

Group 2.

(a) Two reinforced concrete bridge abutments for a bridge south of Webb.

(b) Two reinforced concrete bridge abutments for a bridge south of Maple Creek.

Group 3.

(a) Two reinforced concrete bridge abutments for a bridge east of Davidson.

(b) Two reinforced concrete bridge abutments for a bridge west of Dundurn.

(c) Two reinforced concrete bridge abutments for a bridge north of Asquith.

(d) Two reinforced concrete bridge abutments for a bridge north of Melfort.

Plans, specifications, etc., may be obtained on application to A. J. McPherson, Chairman Highway Commission, Regina, Sask.

Saskatoon, Sask.—Tenders for the erection and completion, with the exception of heating and plumbing, of a reinforced concrete office building to be erected on 2nd Avenue, Saskatoon, will be received until May 25th, 1912. Owner, Chester Thompson, Esq. Plans can be obtained at the architect's office, or the Builders' Exchange, Winnipeg. Frank P. Martin, Architect, P.O. Box 515, Thompson Chambers, Saskatoon.

Toronto, Ont.—Tenders will be received by W. J. Hanna, Provincial Secretary, Parliament Buildings, Toronto, up to noon, May 28th, 1912, for the delivery of coal as required in the sheds of the following provincial institutions, on or before the 31st day of August next, viz.: Brockville, Cobourg, Hamilton, Kingston, London, Mimico, Penetanguishene, Toronto, Hospitals for the Insane, Orillia Hospital for Feeble-Minded, Woodstock Hospital for Epileptics, also the Central Prison and Mercer Reformatory. Specifications of the qualities, etc., may be obtained on application to the department, or from the bursars of the respective institutions.

Toronto, Ont.—Tenders for concrete abutments for a bridge over a branch of the River Humber, Lot 2, Con. 11, Township of King, will be received up to five o'clock p.m. of Wednesday, June 5th, 1912. Tenders for concrete breakwater to protect the highway at or near Woodbridge in the Township of Vaughan, County of York, will be received up to five o'clock of Thursday, June 6th, 1912. Plans and specifications may be seen at the office of Frank Barber, Civil Engineer, 57 Adelaide St. East, Toronto. (See advt. in The Canadian Engineer).

Toronto, Ont.—Tenders for the construction of: (1) One quarry stone abutment for Islington bridge, over Mimico Creek, on Dundas Street, near Islington, and (2) for concrete truss superstructure for bridge over Highland Creek, near West Hill, Township of Scarboro, will be received up to five o'clock p.m., of Tuesday, May 28th, 1912. (3) Tenders for a concrete arch bridge over a branch of the Don on the Townline, Concession 3, between the Townships of York and Markham, County of York, will be received up to five o'clock p.m. of Thursday, June 6th, 1912. Plans, etc., at the office of Frank Barber, Esq., Civil Engineer, 57 Adelaide St. East, Toronto. (See advt. in The Canadian Engineer).

Vernon, B.C.—Tenders for the construction of approximately 50,000 feet of combined sidewalk and curb, will be received until May 27th, 1912. Plans and specifications can be obtained from the City Engineer's office, Vernon, B.C. D. G. Tate, City Clerk.

Vernon, B.C.—Tenders for the supply and delivery of 17,000 feet of 4-inch cast-iron pipe and 10,500 feet of 6-inch cast-iron pipe, will be received until June 10th, 1912. Specifications can be obtained from the City Engineer's office, City Hall, Vernon, B.C. D. G. Tate, City Clerk.

Vernon, B.C.—Tenders for the supply and delivery of 125 gate valves and 36 hydrants, ranging in size from 4-inch to 8-inch, will be received until June 10th, 1912. Specifications can be obtained at the City Engineer's office, Vernon, B.C. D. G. Tate, City Clerk.

Vancouver, B.C.—Tenders will be called for immediately for the construction of ten steel bridges along the line of the Canadian Northern Railway on the Fraser and Thompson Rivers. The bridge plans were designed by J. A. L. Waddell, City Engineer of Kansas City. The first one will be a 420-foot arch span across the Fraser, directly above the Canadian Pacific Railway bridge at Casco, a few miles below Lytton. Then comes a semi-cantilever bridge across the same river at Lytton. The entire cost of the bridges will be a million and a quarter dollars.

Winnipeg, Man.—Tenders for the erection of a court house in the city of Winnipeg, will be received up to noon of June 1st, 1912. Drawings and specifications may be seen at the office of the Provincial Architect, 261 Fort Street. R. P. Roblin, Acting Minister of Public Works, Winnipeg.

Winnipeg, Man.—Tenders for construction of a pile bridge (over Boundary Creek on the Gimli Road), and approaches thereto will be received until May 23, 1912. Plans, etc., can be seen at the clerk's office, Gimli; municipal office, Winnipeg Beach; Public Works Department, Winnipeg; J. D. Forster, secretary-treasurer, Winnipeg Beach.

Winnipeg, Man.—Tenders for the construction of reinforced concrete tunnels at the Agricultural College, St. Vital, will be received up to noon, of May 27th, 1912. Plans and specifications may be seen at the office of the Provincial Architect, 261 Fort Street, Winnipeg. R. P. Roblin, Acting Minister of Public Works, Winnipeg.

Yorkton, Sask.—Tenders will be received up to noon on May 29th, 1912, for the ventilating, plumbing and heating work in connection with the new west end public school building at Yorkton. Plans and specifications at the office of the architect. J. Pender West, 607 Somerset Block, Winnipeg, 9 Dunlop Block, Yorkton.

Barrett Specification Roofs

A CONCRETE CITY

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IN the illustration below the Turner Construction Company, of New York, has brought together in a scale drawing an accurate representation of most of the important modern concrete buildings which they have erected during the past nine years, at an approximate cost of $12,000,000.

It is an imposing display of best types of modern construction—"*a concrete city*" indeed—scientifically designed for maximum service at minimum cost and minimum maintenance.

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Barrett Specification Roofs are a *real economy*, and it is significant that 95 per cent. of the entire roof area is covered with this type of roofing. The figures are as follows:

Barrett Specification type of Roofs	1,490,523 sq. feet
Plastic Roofings	14,714 sq. feet
Slate Roofings	21,640 sq. feet
Tile Roofings	5,619 sq. feet
Ready Roofings	38,381 sq. feet
Copper Roofings	6,355 sq. feet
All other kinds	7,448 sq. feet

It is important to remember that while all these buildings were constructed by the Turner Construction Company, the specifications were drawn by a large number of architects and engineers. That the great majority of these specified a Barrett Specification type of roof, emphasizes the fact that whenever this roof is practicable the best modern engineering practice will have no other kind.

These roofs were selected for one reason only, namely, that they would give *better* service at *lower cost*, than any other roof covering.

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The superior economy of Barrett Specification Roofs justifies their adoption not only on big first-class concrete buildings, but on every flat roofed building from a tenement to a skyscraper—from a small mill to a modern manufacturing plant costing millions—but be sure it's a real Barrett Specification Roof—and the only way to be sure is to incorporate The Barrett Specification in full in your plans.

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CONTRACTS AWARDED.

Calgary, Alta.—Grant Smith and Company and McDonnell, of Vancouver, have been awarded a contract running into over $500,000 for the construction of a large reinforced concrete aqueduct two miles in length near Brooks.

Jansey Bros. and Boomer and Hughes, of Calgary and Spokane, have been awarded a two-year contract amounting to about $300,000 for the construction of a large number of reinforced concrete structures on the canal system in that section of the irrigation block lying between Bassano and Brooks and the Bow and Red Deer Rivers.

The Canada Foundry Company have also been awarded a large contract for the supplying and erection of 30 steel bridges of the main canal system, containing about 1,500,000 lbs. of steel, which, with masonry abutments, will provide practically permanent structures.

Calgary, Alta.—A very large contract has been entered into by Messrs. Jennings & Foster, owners of Lake View Heights, for improvements which call for an outlay of $95,000. They will build a concrete wall around the lake; also boulevards, parks, pleasure grounds and pavilion.

Fredericton, N.B.—Messrs. James H. Corbett and Sons have secured the contract for the construction of the sections of the St. John Valley Railway from this city to Gagetown and from Gagetown to Rothesay, a distance of 66 miles.

The contract for the building of the railway from this city to Woodstock, a distance of sixty-two and one-half miles, was awarded to the Quebec Construction Company, and the contract for the line from Woodstock to Centreville, a distance of about twenty-five miles, has been awarded to Messrs. Kennedy and MacDonald.

Goderich, Ont.—Extension to the north breakwater and dredging; contractor, Wm. Bermingham, Goderich.

Hamilton, Ont.—The Hamilton and Toronto Sewer Pipe Company, Limited, have secured the contract for a considerable quantity of sewer pipe at the town of Exeter, Ont.

Kent County, N.B.—Mr. Whitman Brewer has been awarded the contract for the construction of the James Jardine bridge. The contract price was in the neighborhood of $8,000.

Kamloops, B.C.—Two tenders were received by the city council for construction of cement walks. F. Walkley, $24,000, extra sidewalk 15c per square foot, extra crossings 40c. per square foot and curb 75c. Graff Construction Co., $21,985, extra walks 16c., crossings 14c., curb 40c. per lineal foot. It was decided that the contract be given the Graff Construction Company.

Lion's Head, Bruce Co., Ont.—Extension to wharf; contractor, J. E. Johnston and J. T. Crawford, of Wiarton, Ont.

Moose Jaw, Sask.—The following contracts have been awarded in connection with the Public Library: For heating and plumbing, Frost Bros., and for electrical wiring, the Acme Electric Company. The contract for the heating and plumbing was awarded for $6,695.70; to the Acme Electric for the wiring at $690. Other tenders for the work were the Alexander Plumbing and Heating Company, for plumbing and heating, $6,908; Moose Jaw Hardware Company for same work, $6,980.

Niagara Falls, Ont.—Contracts have been let for the construction of an addition to the plant of the Niagara Falls Canning Company. The papers were executed by Frank H. Boulter, the manager of the company, and call for the expenditure of $100,000.

Ottawa, Ont.—Machinery for 3½ yard dipper dredge; contractor La Cie Pontbriand, Ltd., Sorel, P.Q.

Port Colborne, Ont.—Post Office fittings; contractor, A. E. Augustive, of Port Colborne, Ont.

St. John, N.B.—Dredging in St. John Harbor, N.B., alongside the deep water wharf of the Intercolonial Railway. Contractor, J. S. Gregory, of St. John, N.B.

St. John, N.B.—Messrs. Norton, Griffiths & Company have let the $4,000,000 contract for construction of the mile-long breakwater to Messrs. MacDonald & Boheny, Alexandra, Ont., and G. T. Hervey, Montreal.

Toronto, Ont.—Contracts have been awarded by the Canadian Northern Railway for an electric railway connecting Toronto with Guelph and another line connecting Toronto and Bowmanville.

Vancouver, B.C.—City Engineer Fellowes has successfully recommended the acceptance of the following sewer tenders: Sewer on Keefer Street, Templeton to Union, to Messrs Bruce and Ford, $15,500; sewer on Sixteenth Ave., Manitoba to Ontario, to J. Shunn, $4,258; sewer to China Creek, Seventh to Twelfth Avenue, to the Graff Construction Company, $85,022.20.

Winnipeg, Man.—The following tenders were received and opened by the St. Boniface Council, for the construction of the trunk sewer on Dawson Street to serve the Public Markets, Limited.:

Van Horenbeck and Company, $147,650.75.
Marivet Cotteiner and Graham, $206,970.
Guilbault and Company, Ltd., $149,487.50.

The Van Horenbeck Company was awarded the contract, its tender being the lowest.

Winnipeg, Man.—The contract for the erection of the new St. John's College building, at a cost of approximately $40,000, has been let to Messrs. Worsick Bros.

RAILWAYS—STEAM AND ELECTRIC.

Galt, Ont.—Work has commenced on the spur extension of the Galt, Preston and Hespeler Railway. This will provide railway accommodation for the newly opened factory district.

Province of Manitoba.—A report states that work will be commenced on the line of the Grand Trunk Pacific to Brandon.

Montreal, P.Q.—Recent calculations made by the management of the Canadian Autobusses, Limited, who are negotiating for running rights into this city, show the fifty million persons must be carried to allow a margin of profit on the investment and pay a dividend of 6 per cent. to the shareholders. The company purposed investing five million dollars in plant and rolling stock in Montreal and employing two thousand persons, provided it obtained from the city an exclusive control for ten years. They will put on a service in four months of the date of signing the agreement with the city. In all 286 autobusses will be kept in continuous operation, and the company will have, besides, over sixty autobusses in reserve, bringing the total number to 350.

Saskatoon, Sask. — A report states that the Canadian Northern Railway are about to make a start on improvement work in this locality. The work includes the enlargement of the depot and freight sheds and a new yard. The plans for this work have been approved and the contract will be called in a few days.

South Western Ontario.—It is the intention of the Grand Trunk Railway to lay new 100-pound rails between Woodstock and Sarnia this summer. Sixty section men from Sarnia and points west of London, Ont., have been brought to the latter point, where the work is being started.

Windsor, Ont.—After several months' negotiations between the city and the Detroit River Tunnel Company an agreement has been arranged by which the original assessment of $2,500,000 placed by the Windsor assessor upon the property has been reduced to $444,444. This gives the city $10,000 a year in taxes.

LIGHT, HEAT AND POWER.

Beaverton, Ont.—The municipal council have applied to the Hydro Electric Commissioners for a specific volume of current. Beaverton is the first municipality in this district to make such an application.

Guelph, Ont.—The annual report of the Light and Heat Commission shows that this department has produced a profit of nearly $23,000 for the year ending December 31st, 1911. The following shows the manner in which this amount is made up:—

Total income	$110,188 35
Total expenditure	76,748 97
Net gain	$ 33,439 38
Debenture interest	10,738 85
Balance carried to credit of profit and loss account	$ 22,700 53

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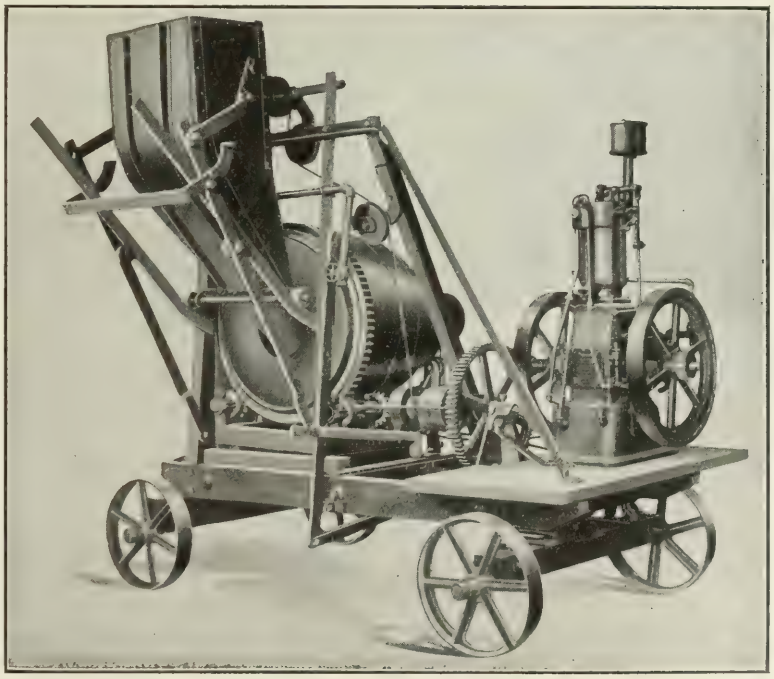

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The income in the gas department was $55,495.34, and in the electric department $54,693.01. The total income was $110,188.35. Expenditures in the gas department were $37,603.59, of which salaries, $6,074, and labor (purification), $21,082.22, were the chief items. In the electric department's expenditure of $28,004.09, the cost of the Hydro-Electric power, $16,437.01, and $3,291.49 for general repairs were the chief items. There were $6,141.29 of general expenditures, depreciation $5,000, showing a grand total of $76,748.97 for expenditures. The balance sheet submitted by the auditors showed assets of $464,400.28, and total liabilities of $269,253.96, principally for debentures, due bank, city of Guelph and open accounts. The contingent fund for depreciation stands at $75,000, and there is a premium of $4,337.20, written up for reserve fund.

Saltcoats, Sask.—The municipal authorities of this town are about to issue debentures for the installation of electric light facilities. The estimated cost for this work is placed at $17,000. Mr. C. E. Boake is secretary-treasurer of this town.

GARBAGE, SEWAGE AND WATER.

Bordeaux Ward, Montreal, P.Q.—The ratepayers of this ward will get a supply of filtered water at an increase of three cents per 1,000 gallons more than the regular price for the crude article.

Berlin, Ont.—The Canadian Fire Underwriter's Association have made a report on the deficiencies in the town fire preventive appliances. In this report attention is drawn to the fact that the water supply is below the requirements of the number of residents and that the pumping facilities are below the amounts required for a single system.

Edmonton, Alta.—The new water filtration plant has been placed in working order, and is reported to be entirely satisfactory. The sedimentation basin has been repaired, and it is now expected that the water supply of the future will be received favorably by the ratepayers.

Montreal, P.Q.—The Board of Control has resolved to send a report to the City Council asking for an appropriation of $17,000 for the purchase of an engine and pump and the construction of a large reservoir tank, which will contain 200,000 gallons of water. The supply is for the higher levels of Montreal, which cannot be served out of the present upper reservoir.

Nanaimo, B.C.—The municipal council will give serious attention to a proposed increase in the water supply to the outer districts of the city.

North Bay, Ont.—Mr. John Shaw, C.E., has presented a report on a proposed water supply from Four Mile Lake, to the municipal council.

Four and one half or five miles of pipe are required in his recommendations.

This lake has an area of 208 acres and a depth of from 10 to 40 feet and with the watershed contains a sufficient supply for a population of 28,000 persons.

Vancouver, B.C.—Two 18-inch water mains have been placed in position for laying across the Second Narrows.

BUILDINGS AND INDUSTRIAL WORKS.

Courteney Bay, St. John, N.B.—The harbor improvements, etc., at this point, for which the Dominion Government has awarded a contract to Norton Griffiths and Co., Ltd., (Canada), are to be completed by March 30th, 1917, and embrace:

The construction of a breakwater 4,570 ft. long, including that of five groynes each 150 ft. long.

The dredging of a channel about 6,800 ft. long and 500 ft. wide at bottom to a depth of 32 feet below low water, from the main ship channel leading into the St. John River to the head of the breakwater mentioned above.

The dredging of a basin to a depth of 32 ft. below low water in Courtenay Bay.

The construction of about 4,890 lineal ft. of quay walls.

The filling of an area of about 28 acres.

The construction of a dry dock of the first-class.

Fort William, Ont.—A report states that an announcement has been made to the effect that the projected programme calling for the erection of a large plant of the Canada Car and Foundry Company in this city has now reached a definite stage and that work on the same will commence at an early date.

Fort William, Ont.—The members of the Fort William Rowing Club have arranged for the erection of a new club premises during the coming year. The cost of this work is estimated at $10,000. Mr. A. A. Wilson is the president of this organization.

Kenora, Ont.—The Public Works Department will commence the construction of a new dock at this point. The dock will cost about $11,800 and will be under the supervision of W. G. Earle, district engineer of this department.

Moose Jaw, Sask.—Mr. R. G. Bunyard has prepared plans for the erection of a new Roman Catholic school building to cost about $25,000. It will be of brick construction with a generous amount of stone trimming, 50 × 82.

Moose, Jaw, Sask.—Plans for the erection of a $60,000 Young Men's Christian Association building for this city have been prepared. It will be three stories in height.

Niagara Falls, Ont.—The American Cyanamid Company have decided to proceed with the extension of their plant. The work involves the expenditure of about $400,000 in reinforced concrete buildings alone.

Port Arthur, Ont.—The Ruttan Estates have begun the construction of a large block for stores and offices on Court St. Estimated cost, $80,000.

J. J. Carrick will erect a two-story brick block for stores and offices on south end of Cumberland St. Estimated cost, $30,000.

It is stated that the James Whalen interests will erect an office block on corner of Lorne and S. Water. Carl Wirth, of Fort William, architect.

Port Colborne, Ont.—Construction work on the plant of the Canadian Union Furnace Company will be undertaken in the course of a few days.

Stratford, Ont.—As soon as the plans for the new Grand Trunk passenger station have been approved by the Railway Board, construction work will be commenced. Mr. U. E. Gillen, superintendent of the middle division has the matter under his jurisdiction.

St. Catharines, Ont.—Messrs. Whitman and Barnes are about to commence building operations on an addition to their plant. The work will entail an expenditure of about $35,000.

Toronto, Ont.—The Engineers' Club have completed the purchase of property in this city, and will erect a new club house. The site of the purchase is near the corner of York and Richmond Streets, and has a frontage of 46 feet.

Vancouver, B.C.—Messrs. Braunton and Liebert, architects, will let the contract within the next ten days for the construction of a modern warehouse, five stories high, on Alexander Street, between Columbia and Main Streets. This building will be 50 feet × 125 feet, and will represent an expenditure of $125,000. It is to be of mill construction faced with with pressed brick.

Vancouver, B.C.—Plans have already been prepared and tenders will be invited in the near future for the erection of a fully modern apartment building on Hastings Street East, for Mr. J. A. Cockburn. This building will be 75 feet square and three stories in height.

Winnipeg, Man.—A report states that a start will be made on the new provincial legislative buildings this year. It is expected that the completed drawings of the successful architects will be finished by July 15th.

BRIDGES, ROADS AND PAVEMENTS.

Dauphin, Man.—The municipal council are making preparations for the construction of certain bridge works to be completed upon the sale of a bond issue now on the market. Mr. J. A. Gorby is secretary-treasurer of this town.

Port Arthur, Ont.—The municipal council have accepted the gift of a tract of land near the reservoir and will commence the construction of a driveway around it.

Moose Jaw, Sask.—The following tenders have been received by the municipal council and will be reported upon by the city engineer. The Bithulithic Paving and Contracting Company, Winnipeg, for $2.90 per square yard for bithulithic paving of five inch thickness, with additional cost of 30 cents per square yard for work between the tracks. The

THE TRIPLEX BLOCK

A Triplex Block hung from a temporary rigging and used for laying pipe.

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MONTREAL ST. JOHN OTTAWA TORONTO WINNIPEG
CALGARY SASKATOON VANCOUVER VICTORIA

Moose Jaw Paving Company, for 16 pound treatment creosoted block at $2.94 per square yard, with an additional 65c. for between the tracks. Fielding and Shepley of St. Paul, for 16 pound treatment creosoted wood paving at $2.84 per square yard, this being the lowest tender. Extra per yard between the tracks in this tender is 30c. The National Paving aind Contracting Company on sheet asphalt at $2.60 per square yard. R. Bangha, Windsor, Ont., at $3.44 per square yard for 2½ asphalt block with an additional 60c. per square yard for between the tracks.

FIRES.

Hamilton, Ont.—The factory of the Diamond Flint Glass Company was badly damaged by fire on the evening of May 18th last. The loss is estimated at $6,000.

Montreal, P.Q.—The premises of the British American Dye Works were damaged by fire on the evening of May 15th last. The damage was confined to the boiler room and the rear portion of the premises.

New Westminster, B.C.—The main factory of the Royal City Mills, together with two boiler-houses, landing platforms and docks, were burned early this afternoon. The loss will be in the vicinity of $100,000, fully covered by insurance.

Owen Sound, Ont.—The saw mill plant of the Carney Lumber Company was destroyed by fire on May 20th last, with a loss of $150,000.

CURRENT NEWS.

Calgary, Alta.—The Civic Industrial Bureau have appointed a committee to confer with the municipal council regarding the erection of an auditorium to house a display of "Made in Calgary."

Calgary, Alta.—The newly formed Tregillus Clay Products Company have awarded the contract for the supply of machinery to Bonnot Company of Ohio, U. S. A. This brick and tile company are arranging for the largest output of materials of this nature in Western Canada and are estimating 10,000 brick per hour as a reasonable output. These will be baked in twenty kilns of the down draft type. The raw material will be brought to the plant entirely by gravity, the location of the plant being admirably adapted by nature, and allowing for excellent drainage. Natural gas and the finest shales in this portion of Canada are at the disposal of the company.

Lethbridge, Alta.—A colony of seventeen ready-made farms will be established by the Canadian Pacific Railway near this city during the coming summer.

Montreal, P.Q.—Improvements to cost $2,000,000 will be begun on the Montreal harbor in a few days. They include the erection of a new 1,200-foot pier, the lengthening of several others, and the deepening of basin No. 1. The entrances to the Lachine Canal will be moved over in their entirety to a point opposite an open space between Mackay Pier and Windmill Point, which is being reserved for the Georgian Bay terminals.

Northern Canada.—The Clergue interests, which are promoting the proposed construction of the Nottoway River Railway, are sending up the steamer Baeotic with a party to make surveys, and the railway department is negotiating to send along a staff of engineers by the same boat to investigate further the question of terminals of the Hudson Bay Railway in connection with the proposal to have a second outlet from the Hudson Bay by way of a railway connecting James' Bay with the N.T.R.

Ottawa, Ont.—It is expected that competitive drawings and designs will be invited for the new Government buildings to be erected on the recently acquired Wellington Street site.

Prince Albert, Sask.—The ratepayers recently voted in favor of the following by-laws:—To raise $73,800 for extensions to the water mains; to raise $19,000 for storm sewers; to raise $21,500 for the city's share of granolithic walks; to raise $55,000 for common sewers. F. H. Creighton, city engineer.

St. Catharines, Ont.—The ratepayers approved of the concessions being granted to the management of the Warren Axe and Tool Company. The management will receive a free site and be exempt from certain taxes for a term of ten years.

St. Croix River, N.B.—Work has commenced on a dredging job that is designed to greatly improve the St. Croix River channel for a distance of four miles. The work is being carried on by the United States Government working under an agreement with the Canadian Government, each country paying a proportionate share of the cost and the Canadian Government maintaining an inspector on the work to protect its interests. The spoil is to be dumped into the river some distance below Mark Point, where the river has a depth of between 60 and 100 feet.

Sydney, C.B., N.S.—A report states that the management of a shipbuilding concern now carrying on negotiations with the municipal authorities of this city has made the following offer:—They ask a bonus of a million dollars in the shape of fifty-year civic bonds in instalments beginning when the plant is completed. They guarantee an expenditure of six millions, five dry docks, minimum of a million on shipbuilding plant. The dock proposed is to be 1,160 feet long, 44 feet at low water and 136 feet in width.

Thorold, Ont.—The head gates at Lock 24, of the new Welland Canal, at Thorold, had a narrow escape from being carried away on Sunday evening last. The steamer Beaverton entered the lock, bound up, when the steel cable that secured her broke and she drifted ahead and opened the head gates a foot or more, pushing them out of mitre. This allowed the water to rush through. This particular pair of lock gates kept back nearly a mile of water in the long and wide level that reaches south to lock 25.

TRADE ENQUIRIES.

The following were among the enquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ended May 5th, 1912:—

A Yorkshire firm of varnish, paint and color manufacturers, oil boilers and tar and rosin distillers are prepared to consider the appointment of Canadian agents.

A Scottish manufacturing firm producing all classes of paints and enamels, and specializing in export trade, are prepared to undertake Canadian business.

A Toronto correspondent desires to secure the agency of a United Kingdom firm manufacturing lines saleable to the drug trade from Winnipeg to Vancouver.

From the branch for City Trade Enquiries, 73 Basinghall Street, E.C.:—

A Midlands firm manufacturing springs of all kinds, also every variety of specialties in wirework and presswork, are looking for a suitable resident Canadian firm prepared to act as their buying agents.

A British firm manufacturing fancy metal photo frames, calendars, cigarette cases, and advertising novelties, desire to appoint a resident representative in Canada.

A German firm of merchants who have experience in chemicals and drugs, dyes and colors, glass and earthenware, machinery, metals and hardware, ores, scientific instruments, textiles, toys, etc., wish to enter into business relations with Canadian houses, either in a buying or selling capacity.

REGINA ENGINEERING SOCIETY WANTS CATALOGUES.

Mr. Edgar I. Wenger, Librarian of the Regina, Sask., Engineering Society, the formation of which was referred to recently in The Canadian Engineer, is starting a catalogue file for the use of its members and would be very pleased to receive trade literature of all kinds from manufacturers of machinery and engineering equipment generally. Mr. Wenger's address is Whitmore Building, Scarth Street, Regina, Sask.

CONCRETE SUB-CONTRACTORS WANTED.

We have about twenty thousand cubic yards of concrete work distributed in small bridges, abutments, head-gates, drops, etc., which we will let to responsible contractors in quantities to suit at good prices.

JANSEY BROS.; BOOMER & HUGHES,
No. 1-2 Mackie Bldg.,
Calgary, Alberta.

Volume 22. Toronto, May 30, 1912

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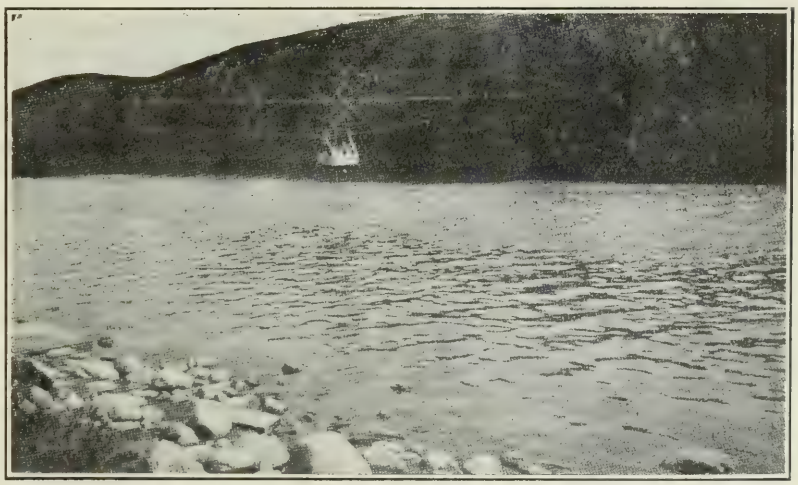
The Canadian Engineer

An Engineering Weekly

STREAM MEASUREMENTS.

In *The Canadian Engineer* dated November 3rd, 1910, was published an abstract of a report presented by Mr. P. M. Sauder to the Dominion Government on stream measurements in Alberta, Sask. Mr. Sauder, as chief hydrographer to the Government, presented his second Progress Report on Stream Measurements recently, and this report has just been issued. The methods used on the work are of interest, and we here present an abstract.

Moosejaw District.—For some time it has been realized that as the country becomes more thickly populated and the towns spring up, there are portions of the West which will not have a sufficient water supply for domestic and industrial purposes. The Council and Board of Trade of Moosejaw for 1909, were among the first to realize that while there is a sufficient water supply in the district, it is allowed to run off into the larger rivers, in the freshets, and the district is left with an inadequate supply during the remainder of the year. They petitioned the Government to investigate and report on the resources of the Moosejaw Creek and the best methods for the development of same.



Cable and Car on Elbow River, at Calgary, Alta.

Two gauging stations were established on the creek; one at a bridge on the N.W. ¼ Sec. 16, Tp. 16, Rge. 26 W. 2 M; and the other at a bridge on the road allowance between Secs. 14 and 15, Tp. 15, Rge. 25, W. 2nd Mer. Daily records were obtained at these stations, and the total annual run-off computed. A careful stadia survey was made of the valley from Moosejaw to a point a few miles above Rouleau, and a map showing the configuration of the surface of the ground by contours of 10-foot intervals, was prepared. While the topographic survey was in progress, a careful reconnaissance was made to discover the most inviting places for the location of dams and reservoirs. Cross-sections were taken at four dam sites offering the best opportunities for storage. The contour map shows the lands which would be flooded by the erection of a dam of any feasible height and tables showing the flooded areas and capacities of the reservoirs were also prepared. A report of this survey is given under the heading of Moosejaw Creek Drainage Basin.

The water supply in the vicinity of Regina, Moosejaw, and along the Soo Line of the Canadian Pacific Railway is limited and it is very important that we should continue a study of the regimen of flow of Moosejaw Creek for several years. This district will be extended during the coming year to include Souris, Qu'Appelle, and South Saskatchewan Rivers. Souris River, which heads in Canada, crosses the International boundary into the United States and then recrosses into Canada and finally empties into Assiniboine River east of Brandon. This river traverses a large territory in Canada and is the only stream in that district. It is proposed to divert it for irrigation purposes, in North Dakota, which may affect Canadian interests.

In all investigations of water resources the most important factor is the available supply. It is also the factor that requires the longest time to determine satisfactorily, owing to the great fluctuations in stream flow from year to year. The stream gaugings already undertaken should, therefore, be continued for a number of years in order that the records may be long enough to show extremes of flow as well as a reliable mean.

The low flow of 1910 has demonstrated the part that municipal water supply and sewage disposal have in the use of rivers and therefore data should be compiled to show the amount of such water supply and sewage and the source of the former (where in surface waters) and the disposal of the latter.

I do not think it necessary to elaborate on the importance of continuing observations during the winter on the more important streams. The minimum flow occurs during that season and should be determined for use in considering power schemes.

Next in importance to a knowledge of the available water supply is a knowledge of the fall of the streams, and the possibilities of storage. This is necessary to determine the value of the river for irrigation, water power, as an outlet for drainage ditches, and as an available channel for flood prevention work. River profile and reservoir site surveys should therefore be commenced as soon as possible on the more important streams of the West.

Definitions.—The volume of water flowing in a stream is known as run-off or discharge. In expressing it various units are used, depending upon the kind of work for which

the data are needed. Those used in this report are "second-feet," "acre-feet," "run-off per square mile" and "run-off in depth in inches" and may be defined as follows:

"Second-foot," is an abbreviation for cubic foot per second and is the body of water flowing in a stream one foot wide and one foot deep at the rate of one foot per second.

The "acre-foot" is the unit capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of one foot.

The expression "second-feet per square mile" means the average number of cubic feet of water flowing each second from every square mile of drainage area on the assumption that the run-off is uniformly distributed.

"Depth in Inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rain-fall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet and depth in inches" represent the actual quantities of water which are produced during the periods in question while "second-feet," on the contrary, is merely a rate of flow per second.

Explanation and Use of Tables.—The data obtained and the estimates made therefrom have been compiled in tabulated form and for each regular gauging station are given, as far as available, the following data:—

1. Description of station.
2. List of discharge measurements.
3. Daily gauge height and discharge table.
4. Table of monthly discharges and run-off.

The description of stations gives such general information about the locality and equipment as would enable the reader to find and use the station. It also gives, as far as possible, a complete history of all the changes that have occurred since the station was established and that might affect the records in any way.

The list of discharge measurements gives the results of all the discharge measurements that have been made at or in the vicinity of the gauging station or have been used in completing the records for the gauging station. It gives the date on which the measurement was made, the name of the hydrographer, the width and area of cross-section, the gauge height and the discharge in second feet.

The table of daily gauge heights and discharges given in this report is a combination of two tables kept in the office of the survey, namely, the table of daily gauge heights and the station rating table. The table of daily gauge heights gives the daily fluctuations of the surface of the water above the zero of the gauge, as reported by the observer. During high water, two observations of the gauge were made at some stations and the gauge height given in the table is the mean of the observations for the day. The discharge measurements and gauge heights are the base data from which the other tables are computed. The table of the daily discharges is the discharge in second-feet, corresponding to the stage of the stream, as given by the station rating table.

In the table of monthly discharge the column headed "Maximum" gives the mean flow for the day when the mean gauge height was highest. As the gauge height is the mean for the day, there might have been short periods when the water and the corresponding discharge were greater than given in this column. Likewise, in the column "Minimum" the quantity given is the mean flow for the day when the mean gauge height was lowest. The column headed "Mean" is the average flow for each second during the month. The computations for the quantities in the remaining columns have been based upon this mean. The drainage area for each gauging station was marked off on the sectional maps of the Department and the area taken off with a planimeter. In many districts, information regarding topographical features is very incomplete and the computed areas are only approximate. As the surveys of the Department are extended and completed these computations will be checked and, if necessary, corrected.

Convenient Equivalents.—The following is a list of convenient equivalents for use in hydraulic computations:—

1 second-foot equals 35.7 British Columbia miner's inches, or one British Columbia miner's inch equals 1.68 cubic feet per minute.
1 second-foot equals 6.23 British imperial gallons per second; equals 538,272 gallons for one day.
1 second foot equals 7.48 United States gallons per second; equals 646,272 gallons for one day.
1 second-foot for one year covers 1 square mile 1.131 feet, or 13,572 inches deep.
1 second-foot for one year equals 31,536 cubic feet; equals 724 acre-feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot for one 28-day month covers 1 square mile 1.041 inches deep.
1 second-foot for one 29-day month covers 1 square mile 1.079 inches deep.
1 second-foot for one 30-day month covers 1 square mile 1.116 inches deep.
1 second-foot for one 31-day month covers 1 square mile 1.153 inches deep.
1 second-foot for one day equals 1.983 acre-feet.
1 second-foot for one 28-day month equals 55.54 acre-feet.
1 second-foot for one 29-day month equals 57.52 acre-feet
1 second-foot for one 30-day month equals 59.50 acre-feet.
1 second-foot for one 31-day month equals 61.49 acre-feet.
100 British Imperial gallons per min. equals 0.268 second-foot.
100 United States gallons per min. equals 0.223 second-foot.
1,000,000 British Imperial gallons per day equals 1.86 second-feet.
1,000,000 United States gallons per day equals 1.55 second-feet.
1,000,000 British Imperial gallons equals 3.68 acre-feet.
1,000,000 United States gallons equals 3.07 acre-feet.
1,000,000 cubic feet equals 22.95 acre-feet.
1 acre-foot equals 43,560 cubic feet.
1 acre-foot equals 271,472 British Imperial gallons.
1 acre-foot equals 325,850 United States gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 acre equals 43,560 square feet.
1 cubic foot equals 6.23 British Imperial gallons.
1 cubic foot equals 7.48 United States gallons.
1 cubic foot of water weighs 62.5 pounds.
1 foot per second equals 0.682 miles per hour.
1 horse-power equals 550 foot pounds per second.
1 horse-power equals 746 watts.
1 horse-power equals 1 second-foot falling 8.80 feet.

To calculate water power quickly: $\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11}$ = net horse-power on water wheel, realizing 80 per cent. of theoretical power.

Methods of Measuring Stream Flow.—There are three distinct methods of determining the surface flow of streams: (1) By measurements of slope and cross-section and the use of Chezy's and Kutter's formulae; (2) by means of weirs, which include any device or structure that by measuring the depth on a crest or sill of known length and form, the

flow of water may be determined; (3) by measuring the velocity of the current and the cross-section. This third method is the one most commonly used by this survey. The second is used when the flow is too small to be accurately determined by the third, while the first is only used in making estimates of the discharge of a stream when the only data available are the cross-section and slope.

Slope Method of Determining Discharge.—The slope of a stream, or rather of a section of a stream, is the difference in elevation between the upper and lower ends of the section, commonly called the fall, divided by the distance or the length of the section. Slope sections vary in length from two or three hundred feet to several hundred feet, depending largely upon the nature of the stream.

It is difficult to ascertain accurately the slope of the water surface in a stream, since in nearly all streams there are pulsations in the water, causing the surface to rise and fall locally. In most streams the slope of the bottom is far from uniform, and the flow of water in any given section is more or less influenced by the flow in the adjacent section, above or below. For this reason it is a good plan to consider a number of adjacent sections, comprising a considerable length of the stream in one computation, being careful to take into account the diversity of cross-section at various places in the length.

In determining the slope of the surface of a stream, levels are taken of the water surface at each end of the slope section, and referred to some datum or bench mark. A good plan is to set firmly a stout wooden stake below the water surface at each end of the slope section, and then to drive a nail into the top of each stake, so that the nail-head will exactly coincide with the water surface. The difference in elevation between the two nail-heads, divided by the distance between the stakes, will give the slope.

The wetted perimeter is that portion of a stream channel that is in contact with the water. The form or outline of the wetted perimeter of a stream has an important influence upon the velocity of the current. It is usually determined graphically from the plotted cross-section or may be measured by means of a flexible tape or chain after the flood has subsided.

The hydraulic radius, which is sometimes called the mean radius of the channel below the water surface is found by dividing the area of the cross-section (in sq. ft.) by the length of the wetted perimeter (in feet).

The Chezy formula, which is the fundamental formula for stream discharge, is:

$$Q = A\,V$$

in which Q = the discharge of the stream in sec. ft.
A = the area of the cross-section in sq. ft.
V = the mean velocity of flow, in ft. per sec.

In applying this formula to the determination of stream discharge, the mean velocity of a stream is considered a function of the slope and one of the wetted perimeter of the stream. This may be expressed by formula as follows:

$$V = C\sqrt{r\,s}$$

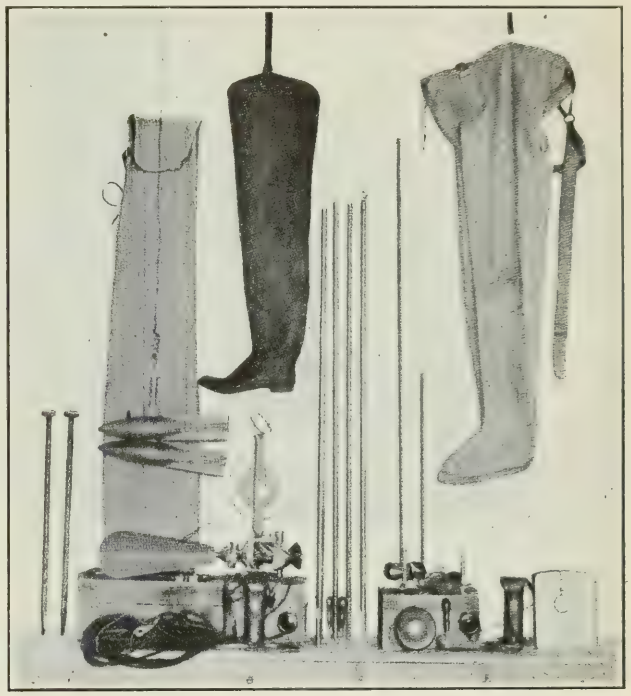
in which r = the hydraulic radius of the channel.
s = the surface slope.
and C is a variable coefficient, depending upon the nature of the channel.

In determining the value of C for any given case it is customary to make use of Kutter's formula, which is:—

$$C = \frac{41.6 + \dfrac{.00281}{s} + \dfrac{1.811}{n}}{1 + \left(41.6 + \dfrac{.00281}{s}\right)\dfrac{n}{\sqrt{r}}}$$

In this formula r and s have the same significance as in the Chezy formula and the new factor n is called the coefficient of roughness. It is a variable coefficient, and its value is dependent upon the size, shape, slope and degree of roughness of the channel. Tables of values of n are given in various text books, but it is difficult to choose the correct value. It is therefore advisable whenever possible to compute the value of n from a measured discharge. As the slope method of determining discharge is seldom employed except to estimate flood discharge, a current meter measurement is very often made at the slope section, during low water. Having determined the mean velocity, slope and hydraulic radius at the time of the metering, the value of C may be found from the formula $V = C\sqrt{rs}$ or $C = \dfrac{V}{\sqrt{rs}}$.

Trautwine's Pocket Book for Civil Engineers and other texts contain tables giving the value of n for different values of



Meters and Equipment for Measuring the Discharge of a Stream by the Velocity of Method.

r, s, and c. From these tables we can interpolate the proper value of n for a particular section of the stream, at low water stage. In most cases this value of n is applicable to high water and flood conditions of the stream also and is used with values of r and s for the high water or flood cross-section to determine the value of C at the higher stage. Having determined the value of C the computation of the discharge is simple.

The results obtained by the slope method are in general only roughly approximate, owing to the difficulty in obtaining accurate data and the uncertainty of the value of n to be used.

Weir Methods of Determining Discharge.—As yet no permanent weirs have been constructed by this survey, and the only regular weir measurements have been on small streams by means of a temporary weir. The weir used consists of a wooden base of 2-inch plank, to which is bolted

a rectangular notch of three-eighths inch steel with bevelled edges.

In making a measurement by means of a temporary weir, the following directions should be followed as far as possible. The weir should be placed perpendicular and at right angles to the bed of the stream with the crest level. The discharge should be free in so much as the nappe should have sufficient fall to allow air to have free circulation underneath it, and the head or depth on the crest should not exceed one-third of the length. The channel of approach should be several times as wide as the opening and the depth of water in the bay or pond should be at least twice the head on the weir, so as to eliminate velocity of approach and cross-currents. In choosing a site for a weir, a point should be chosen that will fulfil the above conditions and give a good sized bay or pond.

To set up a temporary weir, a dam of sods and earth are thrown across the stream, the weir set in place and the sods tramped firmly around it to stop all leakage. On a stream with a sandy bed sods or clay must be placed on the bottom for a few feet upstream to form a mattress to prevent the undermining of the dam.

After the bay has filled up the head of the water is observed by taking the difference in elevation of the crest of the weir and the elevation of the water surface in the bay at a distance of 4 to 10 feet from the weir, with an engineer's level. Two common methods of getting the elevation of the water surface are (1) hold the levelling rod on a stone or other body under water and subtract the depth of water on the rod from the sight on the rod; (2) drive a pin divided into tenths of feet into the bed of the stream so that an even tenth is level with the surface of the water, then hold the levelling rod on the top of the pin and add the length of pin above the water to the sight on the rod.

When the head of water has been determined, the discharge is computed by using one of the standard formulae which will suit the case. Tables giving the discharges for different heads and lengths of crests are published in many engineering texts.

The formula used by this survey for rectangular sharp-crested weirs is:

$Q = 3.33\ (L - .2H)\ H3/2$ being a modification of Francis' formula, to allow for end contractions and elimination of velocity of approach.

in which Q = discharge in sec. ft.; L = length of crest in feet; H = head in feet.

Measurements by means of temporary weirs should be made some distance above or below the gauge. If they are made close to a gauge, the gauge must be read before the weir is placed in the stream and the pond must be allowed to run off after the weir is removed before the gauge is re-read.

Velocity Method of Determining Discharge.—There are two methods of determining the velocity of flow of a stream, namely, direct and indirect. In the direct method by which the velocity is determined by means of floats, the liability of error is large, and the results far from satisfactory. This method is seldom used except for very rough estimates or when a current meter cannot be used. There are three common kinds of floats, viz.: surface, sub-surface and tube or rod floats. In each the procedure in the same. A straight piece of channel is selected for the run and two cross-sections taken at some convenient distance apart. usually from 100 to 200 feet. They are then divided into strips by means of a tagged wire. The velocity in each strip is then measured by noting the time taken by the float in traversing the run or distance between the two cross-sections. As the time and distance are both known the velocity can easily be computed. The velocity, whether measured by surface, sub-surface or tube floats, must be multiplied by a coefficient less than unity to reduce the mean velocity before being used to compute the discharge.

The indirect or current meter method is the most reliable and most widely used method of determining the velocity of the flow of a stream. The meter used by this survey is the Price Patent, manufactured by W. & L. E. Gurley. Troy, N.Y. It consists of six cups attached to a vertical shaft which revolves on a conical hardened steel point when immersed in moving water. The number of revolutions is indicated electrically. The rating or relation between the velocity of the moving water and the revolutions of the wheel is determined for each meter by drawing it through still water for a given distance at different speeds and noting the number of revolutions for each run. From this data a rating table is prepared which gives the velocity per second of moving water for any number of revolutions in a given time interval.

The accuracy of a discharge measurement taken at a velocity-area station is dependent on two factors. the accuracy with which the area of the cross-section and the mean velocity of the flow normal to that section are measured. There is no special difficulty in measuring the first factor, but the second, the velocity, is very difficult to measure accurately, because it is constantly changing. It varies not only from the surface to the bottom but from one bank of the stream to the other, making it necessary to measure it at a number of points.

In making a measurement with a current meter, a number of points, called measuring points, are measured off above and in the plane of the measuring section, at which observations of depth and velocity are taken. These points are spaced equally for those parts of the section where the flow is uniform and smooth, but should be spaced unequally for other parts according to the discretion and judgment of the engineer. In general, the points should not be spaced farther apart than 5 per cent. of the distance between piers, nor farther apart than the approximate mean depth of the section at the time of measurement.

The measuring points divide the total cross-section into elementary strips at each end of which observations of depth and velocity are made. The discharge of any elementary strip is the product of the average of the depths at the ends, the width of the strip, and the average of the mean velocities at the two ends of the strip. The sum of the discharges of the elementary strips is the total discharge of the stream.

Methods of Determining Mean Velocity.—There are a number of different methods of determining the mean velocity at the ends of these strips, or, as it is commonly called, the mean velocity in a vertical, namely, multiple-point, single-point, and integration. These three principal multiple-point methods in general use are the vertical velocity-curve, three point, and two point method.

Vertical Velocity Curve Method of Determining Mean Velocity.—In this method the centre of the meter is held as close to the surface of the water as is possible, being careful to keep it out of reach of all surface disturbances, and then at a number of different depths throughout the vertical. The velocity at each position of the meter is recorded. These observations are then plotted with velocities in feet per second as abscissae and their corresponding depths in feet as ordinates and a mean curve is drawn through the points. The mean velocity for the vertical is obtained by dividing the area bounded by the curve and its axis by the depth. In the absence of a planimeter for measuring the area, the depth is divided into 5 to 10 equal parts, and the velocities of the centre ordinates of these parts are noted. The mean

of these velocities will very closely approximate the mean in the vertical.

It is often more convenient, when the depth is a number of feet and a fraction, as 7.4, to divide the depth into 7 parts of a foot width, and a part of 0.4 foot width. Then the velocity to enter for the narrow part is 0.4 of the velocity at the centre of it.

The vertical velocity curve is useful in studying the manner in which velocities occur in a vertical. From a study of a number of these curves the other shorter methods of determining mean velocity are deduced. This method is not used in general routine measurements, except during the winter, on account of the length of time taken to complete a measurement, for a change of stage is almost sure to occur during a measurement on a large stream which counterbalances the increased accuracy. For this reason its use is limited to the determination of the coefficient to be used in the reduction of values obtained by other methods of measuring velocity to the true value, to the measurement of velocities under new and unusual conditions of flow, and for measurements under ice.

Three-Point Method of Determining Mean Velocity.—This method gives the greatest accuracy outside of the vertical velocity curve and is the method most commonly used by this survey during the open season. The meter is held at 0.2, 0.6 and 0.8 depth. The mean velocity is then obtained by dividing by 4 the sum of the velocities at 0.2 and 0.8 depth plus twice the velocity at 0.6 depth. It is the best method to use during low water or in wide shallow streams having a rough bed where the thread of mean velocity varies considerably from the 0.6 depth.

Two-Point Method of Determining Mean Velocity.—In studying the vertical curves made at a number of different points and under varied conditions it has been found that the mean of the velocities occurring at 0.2 and 0.8 depths gives very nearly the mean velocity in the vertical. Use is made of this fact in the two-point method of determining mean velocity, the meter being held at 0.2 and 0.8 depth in the vertical. This method has been found more accurate than the single point method and the time required for a metering is not very much greater. This method has been found to give, also, a very close approximate to the mean velocity in measurements of ice-covered streams, although these flow under very different conditions from those of open water.

Single-Point Method of Determining Mean Velocity.—Experiments made under most favorable conditions and extending over a long period have established the point of mean velocity in a vertical at 0.6 of the depth. Therefore the error resulting from the use of the 0.6 depth as the depth of mean velocity is very small though in some few cases a study of the vertical velocity curve will show the need of a coefficient to reduce the observed velocities to the mean. The variation of the coefficient from unity in individual cases is, however, greater than the two or three point method and the general results are not as satisfactory. For that reason this method is not employed very extensively by the survey.

In the other principal single-point method the meter is held near the surface, at from 0.5 to 1 foot below the surface; care being taken to sink the instrument below the influence of wind or waves. The resulting velocities must be multiplied by a coefficient to reduce them to mean velocities. This coefficient as found by a large number of experiments, varies from 0.78 to 0.98, depending upon the depth and speed of the stream. The deeper the stream and the greater the velocity the larger the coefficient. In flood work coefficients varying from 0.90 to 0.95 should be used. This method is only used when the current is too strong to permit the sinking of the meter to any great depth below the surface of the water. It is often employed at times of flood, or when a stream is carrying a lot of drift wood or ice.

Integration Method of Determining Mean Velocity.—This method of determining the mean velocity in a vertical consists in moving the meter at a slow uniform speed from the bed of the stream to the surface and return in a vertical direction, the time and revolutions being observed. In travelling through all parts of the vertical the meter is acted upon by each and every thread of velocity from the bed to the surface of the stream, and the resulting observations determine the mean in that vertical.

This method is very useful in checking the results of other methods. It is, however, seldom used by this survey as the Price meter is not suited to observations by this method, since the vertical motion of the meter causes the wheel to revolve.

Gauging Stations.—The first step is to select a suitable locality for a gauging station. Although apparently simple, this is really a difficult task. Not only must the water be moving in nearly straight lines over a solid bed and between well defined banks, but the place must be accessible at

Measuring the Velocity with a Current Meter by Wading.

moderate cost and there must be living near a competent person who can be engaged to serve as observer. Permanent gauging stations should only be selected after a very thorough reconnaissance. In the irrigation districts and in more thickly populated districts there is more or less diversion of water. This is apt to complicate matters for the hydrographer, or a gauging station above all works may not include all the tributaries of the stream and it is often necessary to establish gauging stations at several points along the streams, and on tributaries, canals and pipe lines, in order to obtain complete information regarding the water supply in a particular stream.

There are three classes of gauging stations, namely, wading, bridge and cable stations. The wading station can, of course, only be used in the case of small streams having a maximum depth at its highest stage of 3 feet or less. The equipment for a wading station is small, consisting usually of a plain staff gauge, graduated to feet and hundredths, and fixed vertically to one of the banks of the stream. For convenience a measuring line, usually a wire with tags, may be fixed permanently at this section. When taking the reading, the hydrographer should stand below and to one side of the meter so as to not cause eddies in the water.

Bridge stations, because of their permanency and the freedom of movement allowed the hydrographer, are much preferred. Very often, however, more particularly in swift

currents, the piers materially affect the accuracy of the results. When the gauge cannot be attached to a pier, it is often attached horizontally to the guard-rail or floor of the bridge and the height of the stream is found by lowering a weight by a chain over a pulley. It is indicated by a marker on the chain. Distances of three, five or ten feet according to the size of the stream are marked on the lower chord of the down stream side of the bridge, to serve as a measuring line.

Frequently it is impossible to establish a permanent gauging station at a bridge. In that case the wire cable of a ferry can be utilized, or, if that is not available, a permanent wire cable is stretched across the river. For spans of average length a galvanized wire cable three-fourths of an inch in diameter is safe. It is supported at each bank by means of high struts or by passing it through the crotch of a tree. The cable is run into the ground and anchored securely to a "dead man" buried at least six feet below the surface, or, if convenient, it is anchored to the lower part of the trunk of a tree. A turnbuckle is inserted in the cable between the strut and anchorage to permit tightening the cable when it begins to sag. A permanent measuring line, usually a wire with tags 5 or 10 feet apart, is stretched across the stream just above the cable. A cage large enough to carry two men and instruments is constructed and suspended from the cable by means of cast iron pulleys. The cage is moved from point to point by hand. A stay line, usually quarter-inch guy wire, is stretched across the stream about thirty to forty feet upstream from the cable, and securely fastened. By passing a sash cord through a pulley hung on this stay line the current meter is prevented from being carried down stream.

Low Velocity Limitations.—Owing to the presence of a slight amount of friction in the current meter, a certain definite velocity is required to make the wheel revolve, i.e., to overcome the frictional resistance of the wheel. For this reason the meter is unsuitable for the measurement of low velocities, approaching this value. This velocity, which is required to overcome friction, and which is obtained from the meter rating curve, is called the velocity of no flow for the particular meter referred to. It varies in different types of meters, and also slightly in meters of the same type, according to the time the meter is in use, but very seldom exceeds 0.2 foot per second in any meter. From a number of observations the low velocity limit, below which values of velocity are unreliable, is found to be 0.5 foot per second. In many cases at low stages the gauging station on a stream becomes unsuitable for a discharge measurement owing to the mean velocity in the section falling below the safe limit. In such instances where it is possible to wade the stream a suitable gauging section may be located within a reasonable distance of the regular station and the discharge measurements made at this point. When a gauging is made at a cross-section other than the regular station, sufficient soundings should be made at the latter at the time of the gauging to develope the cross-section and compute the area. The measurement is thus referred to the regular gauging station and the mean velocity and area at the regular section is reported and used in the office computations.

Winter Measurements.—Previous to the season of 1910-11, no records were taken of the flow. During the past winter daily gauge height records were collected for a number of the more important streams in the Calgary and Macleod districts. Discharge measurements were made at these stations at intervals of from two to three weeks.

The laws governing the flow of stream in open channels have, through extensive investigations, become well defined, but the flow under an ice cover has been but little investigated. In winter as in summer the daily discharge of a stream is computed from frequent discharge measurements and daily gauge height observations. In most cases, however, the vertical, velocity curve method is used for the determination of the mean velocity in the vertical, as the mean velocity varies considerably. In fact, there are usually two points in the vertical at which the thread of mean velocity occurs under an ice cover. These points are near 0.2 and 0.8 depths and two-point method will give fairly accurate results, but in this report all discharges are based on computations from vertical velocity curves.

The discharge measurements are made through holes in the ice from 5 to 10 feet apart, and large enough to allow the meter to pass through freely. The measurement is then taken in the same manner as at open sections, except that the depth of the stream is taken as the distance from the bottom of the ice to the bed of the stream. The soundings, however, are always referred to the surface of the water in the holes, the distance from the surface of the water to the bottom of the ice being measured and subtracted from the sounding to obtain the depth. The meter should be kept in the water continuously to prevent the wheel from freezing and sticking.

The gauge is read once a day, the observer noting the elevation of the water as it rises in a hole cut through the ice, the height of the top of the ice, the thickness of the ice, presence of needle or slush ice, snow on top of ice, ice jams, and also any sudden changes in temperature. To do this observers are provided with an ice chisel for chopping holes, and a square to measure the thickness of the ice. Any form of gauge may be used but the chain gauge is the most satisfactory, as the staff gauge being frozen to the ice, heaves with it.

Some of the cross-sections used in the summer were found to be unsuitable for winter measurements. This was usually caused by the cross-section filling up with slush, needle or anchor ice. There is a flow through this ice and it is impossible to measure it. The most suitable stations for winter measurements are those where there is a long stretch of very smooth sluggish water above the station and a rapid fall below.

Re-Rating of Current Meters.—Each meter is rated before being used, in order to determine the relation between the revolutions of the wheel and the velocity of the water. The meter is driven at a uniform rate of speed through still water for a given distance, and the number of revolutions of the wheel and the time are recorded. From this data the number of revolutions per second and the corresponding velocity per second is computed. Tests are made for speeds varying from the slowest which will cause the wheel to revolve to several feet per second. The results of these runs, when plotted with revolutions per second as abscissae and velocity in feet per second as ordinates, locate points that define the meter rating-curve, which for all meters is practically a straight line. From this curve a meter rating table is prepared. Theoretically, the rating for all meters of the same make and type should be the same, but as a result of slight variations in construction, and in bearing of the wheel on the axis at different velocities, the ratings differ. After a meter has been in use for some time the cups may have received small injuries, or the bearing of the wheel on the axis may have changed owing to unavoidable rough usage. These changes will affect the running of the meter and change its rating. As a consequence each meter is re-rated at regular intervals and a new rating curve and table prepared. During 1910 several meters were re-rated by F. H. Peters by means of a gasoline launch on Chestermere Lake, and with only one excetion the meters varied but little from the original rating.

The boat method of rating meters is, however, very crude, and Mr. Peters has designed an up-to-date rating station consisting of a concrete lined tank, 250 feet long, 6 feet wide, and 5½ feet deep, and a car operated by a motor. This will be constructed at once and all the meters will be carefully re-rated at regular intervals.

Office Computations.—Rating Curves and Tables.—When a series of discharge measurements has been made at a gauging station a rating curve is constructed for that station, showing graphically the discharge corresponding to any stage of the stream within the limits covered by the gaugings. This curve, as it is usually drawn, has an abscissae, the discharges in second-feet and as ordinates, the corresponding gauge heights at which the discharges were made. A smooth curve is drawn through the resulting set of points and from this curve the discharges at any stage within the limits of the curve are taken. Some measurements may be more reliable than others owing to more or less favorable conditions at different times of gauging, or to other causes. In order to obtain the weight of the different measurements, curves with area and mean velocity, as abscissae, and gauge heights as ordinates, are also drawn. From a study of these curves any discrepancies in a measurement, either in its area or mean velocity, may be detected. Should it be necessary to extend the rating curve beyond the limits of actual discharge measurements the area and mean velocity curves may be constructed to the stages for which the discharge curve is desired and the latter found by taking the product of the two curves. The discharge curve under natural conditions of flow is always convex to the gauge height axis. The area curve is either a straight line or is convex to the gauge height axis, except in the case of overhanging banks when it becomes concave to the axis. This mean velocity curve is always concave to the gauge height axis, except in cases where standing water occurs below the stage of no-flow. In this case the curve will assume a reverse form, starting from the gauge height of zero flow with a curve convex to the gauge height axis and gradually reversing to a curve concave to this axis. In plotting all three curves the horizontal and vertical scales should be so chosen that the curves may be used within the limits of accuracy for the work, and in their critical position will make, as nearly as possible, angles of 45 degrees with each axis.

The rating curve being constructed, it becomes necessary to prepare a station rating table, giving the discharge at any stage of the stream within the limits of the daily gauge height observations on record. From this rating table the daily discharges corresponding to the daily gauge heights are read and tabulated. The rating table is constructed for tenths, half-tenths, or hundredths of feet, according to the readings of the gauge to which it is to be applied. The discharges for this table are read directly from the rating curve and are then adjusted so that the differences for successive stages shall be either constant or gradually increasing, but never decreasing, unless the station is affected by backwater.

Daily Discharge, Monthly Mean, and Run-Off.—The rating table being made to cover the range of daily gauge height observations, the next procedure in the computations is to make out a table of daily discharges from this rating table. The daily gauge heights are copied as they were sent in by the observer and opposite each the corresponding discharge is filled in from the rating table. The monthly discharge is found by totalling the daily discharges for the month in question and the monthly mean is obtained by dividing this total by the number of days in the month.

The run-off is computed with two different sets of units, depending upon the kind of work for which the data is intended, as follows: (1) Run-off in inches is the depth to which a plane surface equal in extent to the drainage area would be covered if all the water flowing from it in a given time were conserved and uniformly distributed thereon; it is used for comparing run-off with rain-fall, which is usually expressed in depth in inches. The mean run-off in second-feet per square mile for each month is used. The monthly mean run-off in second-feet is divided by the area of the drainage basin in square miles to find the monthly mean run-off per square mile. This result, reduced to run-off in depth in inches for the monthly period, is in the form required.

(2) The run-off in acre-feet is the form of most use in connection with storage. An acre-foot is equivalent to 43,560 cubic feet, and is the quantity of water required to cover an acre to the depth of one-foot. The monthly mean run-off in second-feet is used for the computation of run-off in acre-feet. The monthly mean is reduced to cubic feet per month and this quantity divided by 43,560 gives the run-off in acre-feet.

Thirty-Six-Inch Sharp Crested Rectangular Weir Used on Small Streams.

The run-off of the stream being computed both in depth, in inches and in acre-feet for each month, the run-off for the period, during which observations of run-off were made, is found by the summation of the amounts of run-off for the several months making up this period.

Changing Conditions of Channel.—On streams such as Milk River, whose bed is in a constant state of motion, measurements of discharge should be made every few days, otherwise considerable data relating to changes cannot be obtained. For discharges on days other than those on which measurements are taken, the interpolation method is used. The two methods of interpolation in general use are the Stout and Bolster Methods.

The Stout method deals with the correction of the gauge heights. A curve is drawn, using the difference between the actual gauge heights at the time of measurement and the gauge height corresponding to the measured discharge as ordinates and the corresponding days of the month as abscissae. From an irregular curve drawn through these points corrections for gauge heights can be made for days on which there was no discharge measurement. When the

discharge is greater than that given by the curve the correction is positive and vice-versa. Each daily gauge height is corrected by the amount shown on the correction curve, and the corresponding discharge taken from an approximate rating curve for the station.

The Bolster method deals more particularly with the modification of the discharge. Results of discharge measurements covering a whole year or season are plotted, and though considerably scattered, will define one or more regular curves, called standard curves, the number and position of each indicating the radical changes. Where the river bed changes from day to day, the position of the standard curve also varies and must pass through the points indicating the different days. The points indicating two successive measurements are joined by a line, which for short distances on the cross-section paper is a straight line and otherwise a curve. This line is divided into a number of equal parts, each indicating an intervening day, the assumption being that as the change during this period is gradual the daily rating must pass through each point, or day, as represented by the divisions. A simple and convenient way of making these interpolations and moving the daily rating curve is to make a tracing of the standard curve with a vertical line of reference. By keeping the lines of reference coincident this curve can be shifted into any desired position and the discharge read for any gauge height.

PUMPING TERMS.

A number of different terms are used in connection with pumping, and very often it is hard to determine just what is meant by certain designations. The accompanying dia-

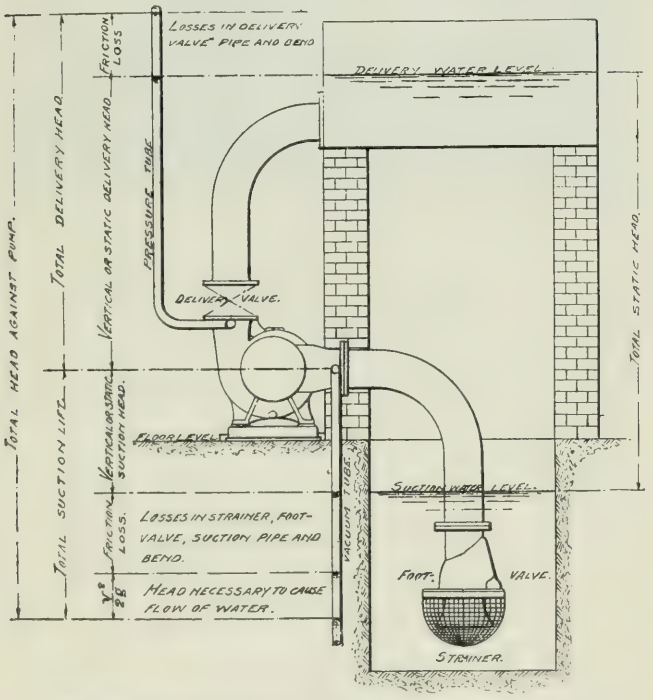


Diagram illustrating the Terms generally used in connection with Pumping.

gram, reproduced through the courtesy of Drysdale & Co., Limited, Yoker, Glasgow, W., from a pamphlet issued by them, shows graphically and clearly the meaning of the different terms.

AUXILIARY PLANT FOR POWER STATIONS.

By A. H. Finch, M.A.

(Continued from last issue.)

Auxiliaries as Labor-Saving Devices.—We now come to another class, or sub-division, of auxiliaries; those, that is, which are in reality, only substitutes for labor. It is here that a temptation towards multiplication is so often evident. Certain of them, however, are so obviously superior to the intermittent or collectively large amount or labor which they displace that there is usually no question as to the advisability of adopting them; such are water-service pumps and coal-handling machinery, cranes, and bilge pumps. In the case of cranes, it is the ability to concentrate the requisite power into a small space that is valuable; with coal-handling machinery it is advantageous in any event to use some form of mechanical lifting appliance, and the question of applicability of the power settles at once the method of driving.

Stokers.—No such argument applies to mechanical stokers. Here the question is between an expensive appliance, capable of giving smokeless combustion and better efficiency due to absence of frequently-opened doors and more even distribution of fuel, and a cheap arrangement involving a larger amount of labor and producing poor combustion at times. No comparison in an exact sense is possible, for the reason that the conditions prevailing in any given station—such as load factor or number of shifts worked—will radically influence the figures.

The following illustration is intended to apply to a boiler house running on a load factor of about 60 per cent. with three equal shifts, capacity 8,000 kw. The capital costs are taken to be:—

For mechanical stokers, shafting, motors, and wiring, and dumping gear	£3,460
For fire-bars and furnace fronts adapted to hand firing	320

Capital charges taken at 15 per cent. Maintenance charges on mechanical stoker gear, at 10 per cent., and on hand-firing apparatus, due to wastage of fire-bars, at 80 per cent.:—

Mechanical firing—	
Capital charges	$ 519
Maintenance	346
Power, say 16 kw. for 4,600 hours per annum at 0.25d.	77
Labor, 3 shifts at 125s. per week per shift	975
	£1,917
Hand firing—	
Capital charges	48
Maintenance	256
Labor, 3 shifts at 245s. per week per shift	1,910
	£2,214

In this instance there is apparently a balance of £300 in favor of mechanical stokers, making out a fairly obvious case. If, however, no night shift (in the ordinary sense) is worked, the necessary night attendance, if any, being in both cases the same, the mechanical arrangement is reduced to £1,592, and the hand firing to £1,577, and in such a case a more careful inquiry into the actual figures for maintenance, cost of power, etc., obtained in practice might point to adopting hand firing in spite of the better combustion obtained with the alternative method. Or, again, if we con-

sider the case of an installation where native labor is available, the account for a 3-shift load might stand as under:—

Mechanical stoker—	
Capital charges as before	£ 519
Maintenance as before	346
Power as before	77
Labor, 3 shifts at £104 per shift per annum, being composed of twice the number of men assumed in the previous example, but at something like one-sixth the rate	312
	£1,254
Hand firing—	
Capital charges	£ 48
Maintenance	256
Labor, 3 shifts at £200 per shift per annum	600
	£904

showing a substantial advantage in hand firing.

Clearly, then, the labor conditions and the nature of the load are weighty factors in settling such a point. In fairness to the stoker method, it must be pointed out that better combustion generally results from its use, and inferior coals can be successfully burned. On the other hand, the method of hand firing offers greater flexibility and enables a wide variety of coals (as regards their components) to be used. Hence it is that no exact comparison is possible without details being in every case considered; while a further factor is the limitation imposed by the length of grates where very large hand fired boilers are involved. In such cases the necessary grate area can only be obtained by increasing the width of boiler, which may lead to structural difficulties and an abnormal amount of floor space.

Ash Handling.—Another item in which the labor question is a prominent feature is ash handling. Owing to the nature of the material, all mechanical apparatus, except of the simplest character, is a source of excessive maintenance costs. On the other hand, the conditions under which ashes have to be handled make it difficult to obtain labor at a reasonable rate. Where tunnels are used they are often unbearably hot, or, being situated below everything else, and liable to choked drains, they readily become flooded. Large quantities of dust are produced in the process of handling, and if quenching or spraying is resorted to, this results in the formation of active corrosive agents.

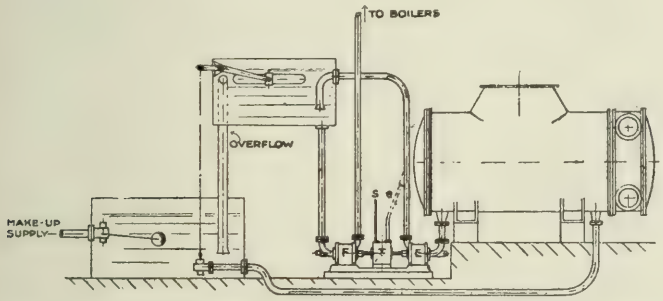


Fig. 1.—Diagrammatic Arrangement of Proposed Closed-Cycle System of Boiler Feeding.

E = Extract on Pump. F = Feed Pump. T = Auxiliary Turbine. S = Steam to Auxiliary Turbine. e = Exhaust from Auxiliary Turbine.

Systems have been developed in which air or water is the conveying agent, and these have the advantage over any mechanical system in that the handling involved is a minimum, and no moving machinery is required except a pump, which can be placed out of reach of damage from the dust, and a breaker or crusher. With this arrangement there is necessarily considerable wear on the tubes or channels which convey the ashes; but such parts are cheaply replaced. The drawback of the system, from the point of view we are now considering, is that it introduces two auxiliaries, viz., the crusher and pump; but the former can be a very robust piece of apparatus. The channels for conveyance of ashes can be brought close up to each boiler, and by using suitable means for introducing them into the crusher or channels, dust can be effectually confined.

Where the conditions of manual operation are so unfavorable, there is a strong case for mechanical handling, but the choice of apparatus should fall on that which can be made of the stoutest construction, a consideration which would operate against conveyors, elevators, or hoists of the usual description.

Switches.—The working of switches is a question wherein ease of manipulation from a distance is the paramount consideration. To bring the control of a large number of switches into any convenient compass can, it is true, be accomplished in the same way as with railway signals and points, by a system of levers and rods; but this system is being replaced on important signal installations by electricity, either alone or in combination with compressed air. In a power station where electrical manipulation is unaccompanied by exposure of apparatus to the rough conditions of a railway track, it is obviously indicated in preference to a purely manual process for control of a large number of switches, failure of the current being a remote contingency owing to the invariable practice of employing a battery.

There remains for consideration a class of casual services whereon motors are often employed, such as water softeners, weighbridges, air compressors, and boiler-cleaning pumps. The general principle applicable to such cases is that the extent of use should settle the method of driving. To take the cases cited; the softener may be used continuously, and so require regular attendance, or intermittently, being idle for weeks. In the former cases power operation is justified, in the latter, not; unless, owing to great size, manual labor cannot be advantageously employed. Weighbridges of a type in which a motor is necessary to move counterweights or raise the table only justify themselves by frequency of use. Air compressors, universally used for cleaning electrical apparatus, are a necessity in a large power station, but a luxury in a small sub-station where bellows will do the work; and boiler-cleaning pumps (for use with water-tube boilers) become necessary where the frequency of use is such that a boiler feed pump cannot be spared for the purpose, or where soft water is used for cleaning and the risk of getting it into the boilers cannot be run.

Certain auxiliaries are to be found associated with the purely electrical portion of a station, which do not fall exactly into either of the two arbitrary divisions that have been discussed. Such are fans for ventilating electrical apparatus whether rotating or stationary. The measure of the value of these is, in general, the degree to which they increase the capacity of a given weight of copper or iron in electrical apparatus. With rotating plant, the alternative is ventilation by what really amounts to a fan on the rotating portion of the generator itself; and as the rotating of this portion in most designs is necessarily accompanied by some fan action, it would appear a logical extension of the principal to make the rotor do the whole work of ventilation, the slight additional power requiring no increase in the shaft or bearings. Clearly, then, an auxiliary fan is not justified in this case, unless the conditions are such (for in-

stance) that air has to be brought to the generator from a distance in an enclosed duct, the friction of which, unless it be unduly bulky, might result in an insufficient supply; or where air filters are necessary; or, in similar circumstances, when the resistance to be overcome is greater than can be dealt with by a rotor fan whose speed and diameter are fixed by those of the generator.

With non-rotary apparatus, such as transformers, the method of direct ventilation by air finds an alternative in cooling by oil, or water. Oil is of necessity the immediate cooling agent of the metal. It is practicable to cool the oil either by water-pipes within the transformer case, or by passing it through an external cooler, wherein water is circulated. Where a supply of water exists under sufficient head, a water pump is not necessary; but an oil pump is introduced with the method of external cooling. This is against the method; its advantage lies in more effective cooling and a reduction in the risk of leakage of water into the oil, which can be accomplished by giving the oil within the cooler a higher pressure than the water. Any system of water cooling has the advantage over the usual methods of fan cooling that the heat abstracted is not liberated within buildings; more important perhaps in tropical climates than in these latitudes.

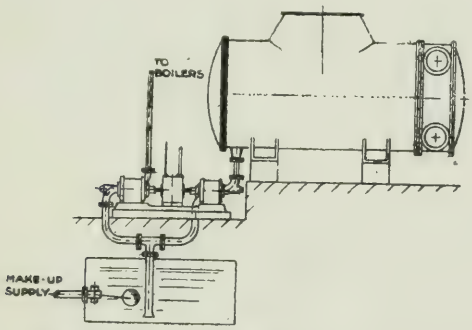


Fig. 2.—Diagrammatic Arrangement of an Alternative Closed-Cycle System of Boiler Feeding.

Exciters almost claim a place for themselves, particularly since so much attention has always been devoted to the subject. As between the independently-driven machine, and one directly coupled to the shaft of the alternator it is intended to excite, the arguments may be grouped thus:—

Against the direct coupled exciter—(1) Small size and inefficiency. (2) In turbine stations, addition to length of whole unit which may require a wider engine-house. (3) Cumulative effect on bus-bar pressure of a fall in speed. (4) Inability to be used for station lighting, etc.

Against the independent exciter—(1) Cost of separate engine or motor (usually the former) to drive it. (2) Cost of running the same, including maintenance and ultimate coal consumption. (3) Duplication.

Given sufficiently good voltage regulation, the method of direct-coupled exciter, even if accompanied by motor generators for battery charging or station lighting, produces a simpler total combination and one more easily kept in an efficient state of repair.

Methods of Driving Auxiliaries.—Three systems are in vogue, viz., electricity, steam (for certain limited services) compressed air. The last is the least efficient, but has the merit (where a reservoir is provided) of being to some extent independent of failure of the main supply.* For an infrequent service such as valve operation, economy ceases to be of importance, and the use of air may be justified by cheapness of the actual engine and piping employed in comparison with an electric motor and wiring. On the other hand, an independent source of power, viz., air compressor, is necessary, whereas auxiliary current at most requires only a transformer. On general grounds, since a power station must employ steam and generate electricity, it would seem preferable to use one of those agencies rather than air, which requires additional apparatus and only introduces an indirectness in the application of power.

*Employed for this reason in actuating the brakes on some form of electrical winding gear for collieries.

Steam v. Electricity.—As between steam and electricity, the principle suggested is that steam should only be used where it introduces a simplification, not so much in respect of economy as by offering a simpler combination of apparatus. This is said with particular reference to the use of exhaust steam for feed heating. Where the exhaust cannot be so used, either wastefulness is introduced by exhausting to atmosphere, or complication ensues from the addition of an auxiliary condenser, and possibly an oil separator, to the total of auxiliary plant.

Let us examine the case of a direct-acting feed pump working without lubrication. It consumes anything between 65 and 100 lbs. steam per water horsepower per hour, say 75 lbs.; whatever the pressure at release, in round numbers the exhaust carries away 1,200 B.T.U. (reckoned from 0 deg. F.) per lb. To fix the ideas, consider a 1,000-kw. turbine, using 18,000 lbs. steam per hour. With boiler pressure 175 lbs. per square inch, the water h.p. is 3.58, and the pump steam per hour $= 3.58 \times 75 = 268$ lbs. Therefore the heat available for feed heating is $268 \times 1{,}200$, or say 320,000 B.T.U. If the initial temperature of the feed be 90 deg. F. (28 in. vacuum corresponds to 101 deg. F.) each pound contains 90 B.T.U. reckoned from zero, and the whole feed contains $18{,}000 \times 90$, or 1,620,000 B.T.U. The final temperature therefore becomes—

$$\frac{1{,}620{,}000 + 320{,}000}{18{,}268} \text{ or } 100 \text{ deg. F.}$$

In this case, an expenditure of $\frac{268}{6.5}$, say 41 lbs. of coal of coal per hour, pumps the necessary feed, and heads it by 16 deg. F.

To effect a comparison, we may consider pumping the same quantity of water electrically, and heating the feed by live steam, assumed at 175 lbs. per square inch:—Water h.p. $= 3.58$; efficiency of pump and motor, 60 per cent. Then power required by motor, in kw. $= 3.58 \times \frac{5}{6} \times 0.746 = 4.5$ kw., which at 3 lbs. per kw.-hour, would result in a consumption of 13.5 lbs. of coal per hour. Quantity of steam to heat the feed 16 deg., $= 256$ lbs., requiring $\frac{256}{6.5}$ or 39.4 lbs. of coal. Total coal by this method, 44 lbs. which is therefore inferior as regards both steam economy and power to vary speed within wide limits.

Thus, apart from the question of capital cost, which is almost certainly in favor of the steam pump, a clear case can be shown for steam. But such superiority might vanish if, owing to the introduction of lubricant, an oil separator were rendered necessary, or the exhaust were wasted. Small reciprocating engines are inferior to electric motors in respect of upkeep, coal consumption, and stand-by losses when not in use, but kept ready for use; but small turbines are not necessarily so.

Reference was made at an earlier stage to a set consisting of a small turbine driving the condensing auxiliar-

ies; and it was shown that certain advantages accrued to such a use of steam if the exhaust could be profitably employed. We thus arrive at an argument of the following order:—In modern high-vacuum plants, the air-pump discharge is so much reduced in temperature that if introduced into an economiser without further heating it would cause sweating of the pipes. Consequently feed heating is a necessity. Steam feed pumps and turbine-driven condensing auxiliaries can be shown to have a thermal superiority over similar electrically-driven services if the exhaust be used to heat the feed, and are compact and easily maintained. To the extent, then, that the exhaust can be usefully absorbed for this purpose steam driving is clearly indicated for such services. But if the use of steam involves either waste of the heat of exhaust or the introduction of additional appliances, it ceases to have any recommendation as against electricity, with a possible exception in cases where speed variation within wide limits is required. It has been argued that steam offers a protection against failure of the auxiliaries in company with the main generators when a complete electrical breakdown occurs. In the system just described, the auxiliaries most essential to the restarting of the plant, viz., those connected with the condensers, would be steam driven.

To the advantage of steam it is to be added that it detracts nothing from the capacity of electrical generating and transforming plant, and little more from that of boilers than does an electric service.

Electric power, on the other hand, while it detracts from capacity of alternators, etc., has the following broad advantages:—(1) Small attention required while running. (2) Relative ease of installation at any distance. (3) Ease of control from any desirable point. The latter quality is particularly useful in the case of motors which drive stoker gear or fans; or for an object like a coal conveyor which extends over a great length and may have to be stopped from anywhere in case of accident.

Means of Providing Power.—Where steam is employed it can usually be taken from the main range. Cases sometimes arise where the main supply is superheated, but saturated steam is required for, say a feed pump; in such cases, provision can be made by drawing the saturated steam supply from two or three boilers, which are not likely to be shut down all at the same time. As regards electricity, the distinctive advantages of the three-phase current (absence of brushes or commutator, and solid and cheap construction) and its disadvantages (invariable speed) are well known. A three-phase supply for auxiliary circuits may be provided by three different methods:—(1) By separate transformers connected with each generating unit; (2) by transformers from the bus-bars; and (3) by separate auxiliary generating sets.

(1) The first-named, generally known as the complete unit system, wherein all the auxiliaries connected with any main generator are driven from a transformer attached to that generator, possesses advantages in the matter of reliability, but it is obviously costly. In isolated stations and with electrically-driven condensing auxiliaries, it is justified if not pushed to excess, as is liable to become the case where the boiler-house is concerned. Without an altogether disproportionate amount of spare boiler plant, each boiler-house or group of boilers must be considered the common property of the engine-house. Consequently a unit system must be interconnected in some way, which leads to expense and begins to vitiate the principle of unity. But apart from this, the argument against the alternative of driving from bus-bars, which is valid in the case of the turbine auxiliaries, is not necessarily applicable to the boilers. For a bus-bar failure, or a failure of one of the station transformers, does not vitally affect the supply of steam, if feed-pumps are steam-driven, and natural draft can be substituted for artificial; the grates (if mechanical) can be operated by hand, for long enough to enable the bus-bars to be made alive again, or the reserve transformer switched in. Coal or ash-handling plant, or the crane, cannot be allocated to any one turbine. It thus becomes necessary to have in any case a connection from the station bus-bars to the unit transformers. Apparatus which is inalienable from its own generator is usually confined to air pumps; and in some cases, circulating pumps and ventilator fans. Where the circulating and air pumps are steam-turbine-driven, and the alternator supplies its own draft, the principal arguments for the unit system are absent.

(2) A supply from the main bus-bars through transformers has an advantage over either of the other methods in the matter of initial cost. The transformers detract, of course, as much capacity from the main alternators as the unit method, and have to be in duplicate. Otherwise this system is exceedingly simple and obvious.

(3) The recommendations of the independent method are protection from electrical breakdown of the main system, and increased saleable capacity in the main alternators. The cost is necessarily much greater than that of the bus-bar method, and space has to be found for at least two auxiliary steam-driven generators with their equipment.

A supply of continuous current from a three-phase station can be furnished (1) by motor-generators, with or without a battery; (2) by independent generators. The advantage of continuous current is its particular applicability to variable-speed services, cranes and locomotives. With the addition of a battery, auxiliaries are quite independent of the state of the main bus-bars. After these things are granted, its disadvantages soon become apparent in the upkeep of commutators and brushes, increased initial cost, and perpetual loss in conversion by motor-generator or storage in the battery. This, of course, would not apply in a D.C. station.

In some cases where alternating current is generated, the device has been adopted of having some auxiliaries driven by alternating, and others by direct, current furnished by a motor-generator in normal operation, and by a battery if the supply fails. Thus some at least of the auxiliaries, and the station lighting, can always be kept going. But the introduction of two electrical systems is objectionable.

Conclusion.—We may now summarize the conclusions indicated by the foregoing remarks. Starting from the assumption that a large station is to generate three-phase high-tension current, certain services must be arranged for, some driven by steam, others by electric power. Preference is to be given to three-phase current which can be provided for either by independent generators, by transformers from the bus-bars, or by transformers from each generating unit. Being necessarily in duplicate and steam-driven, independent generators are a costly means for obtaining the power. It has been shown that turbine-driven air and circulating pumps, with the possible addition of feed pumps on the same shaft, besides fulfilling a useful and economical function in heating the feed, render unnecessary a subdivision of auxiliary services into unit groups. Therefore, it is submitted that such pumps, with other electric auxiliaries supplied by transformers connected only to the station bus-bars, combine simplicity with a sufficient measure of reliability. The transformers must, of course, be in duplicate. But where

for any reason, such as small size of units, with consequent wasteful consumption on auxiliary power, or excessive power rendered necessary by exigencies of the pumping system, steam cannot be economically adopted (having reference to the heating of the feed water), a grouping of motors into units, in which either one or two generators may participate, with electrically-driven condensing auxiliaries, is to be recommended on the score of immunity which it furnishes from simultaneous breakdown of all auxiliary services.

The following services may with advantage be electrically operated:—Mechanical stokers, if fitted; fans, if fitted (variable speed motors are desirable here, if efficient at low speeds; water service pumps of all sorts, except those very rarely used, where steam ejectors can be employed; economizer scrapers; coal and ash-handling plant; cranes.

The following should, where possible, be steam-driven: —Feed-pumps, and combined air and circulating pumps for the condensers.

Exciters should preferably be directly attached to the shafts of their generators.

Ventilation of alternators to be effected by fans on the rotors.

Switches to be electrically operated.

Large valves where speed of operation is essential may be operated either electrically, or, if the station is on a large enough scale to warrant a supply of compressed air always available for cleaning electrical apparatus and driving pneumatic tools, by air.

We may conclude by a brief reference to the tables which are appended to the Paper. Motor-generators and auxiliary D.C. sets are shown in separate column, as their inclusion among auxiliaries proper would be misleading. Steam feed pumps are estimated. A great divergence is exhibited in the degree to which auxiliary power is actually employed. Local peculiarities account for some of this divergence. For instance, in the case of Greenwich power is wasted due to the leakage of circulating water in connection with the straining appliances rendered necessary with Thames water, and electrically-driven feed pumps bulk largely in the total. At Carville, the station being set back some distance from the river in order to obtain suitable foundations, the power required for pumping water is considerable: on the other hand, practically none is needed for coal-handling owing to the advantageous use of the natural levels of the ground.

Of the two Glasgow stations, one (St. Andrew's Cross) employs fan-draft cooling towers, the other a canal. Hence the high figure in the case of the former.

At Stepney circulating pumps and fans account for much of the power. The latter also contribute a large proportion in the case of Brighton and Carville. In fact it is almost correct to say that they constitute the principal difference between the high figures and the low figures at Dunston where fan power is moderate and not duplicated.

Cambridge is of interest because it exhibits another factor of the auxiliary question. Being started as a single-phase station in days when single-phase motors were unsatisfactory, the bulk of the power is furnished by steam 12 h.p. only being electrical; the air and circulating pumps are for the same reason driven by gearing from the main turbines.

The installation of induced draft apparatus accounts for a large proportion of the power at the Newcastle and District Company's station. As a matter of everyday practice induced draft is not used there, but the fan motors are included because a classification has to be made on an uniform basis for comparison. The rated power of motors installed, which is the figure stated, is roughly a measure of the capital spent on auxiliaries. The daily energy used, which would be more indicative of the annual cost, might have been selected, but such a figure would be difficult (in some cases impossible) to arrive at: and the former figure perhaps brings out in a more striking fashion the importance of the whole question from the capital point of view.

Table I.—Aggregate of Auxiliary Power Installed at Various Stations.

STATION	Total main generating plant. kw.	Auxiliary power installed h.p.	Motor-generators or Auxiliary steam sets.	Auxiliary power h.p. per 1000 kw. of Main Plant.	Remarks
Lots Road, Chelsea	48,000 3-ph.	2,223	Four 135-kw. steam.	46.5	The 4 steam sets supply excitation and some D.C. motors.
Carville	35,000 3-ph.	3,411	Two 25-kw. One 100-kw. M.G.'s	97.5	
Greenwich (L.C.C.)	34,000 3-ph.	2,064	Two 150-kw. steam.	61	
Glasgow— Port Dundas	22,400 3-ph.	1,850	Two 40-kw. M.G.'s	80	
Dunston	19,000 3-ph.	1,184	One 9-kw. Two 50-kw. One 200-kw. M.G.'s	62	
Glasgow— St. Andrew's Cross	16,400 3-ph.	1,725	Two 40-kw. M.G.'s	105	Fan—draft cooling towers.
Brighton	10,200 3-ph.	912	Two 220-kw steam. Two 300-kw. M.G.'s	90	Motor-generators and steam sets used also for external load.
Hamburg Overhead	7,900 3-ph.	590	—	74.5	Condensing auxiliaries and feed pumps turbine-driven.
Markisches (Berlin)	7,200 3-ph.	508	—	70	
Stepney	6,000 D.C.	580	(D.C. Station)	96	
Newcastle and District Co.	5,450 D.C. & 1-ph.	473	(D.C. Station)	87	
Cambridge	1,880 1-ph.	117	One 45-kw. M.G.	62	Single-phase generators. Motor-generator for external load.
Alnwick	140 D.C.	15	—	107	Non-condensing.
Morpeth	60 D.C.	12.5	—	210	

* Figures for Greenwich are as regards 85% taken from a Paper read by Mr. Rider before the Inst. E. E. in 1909.

Table II.—Analysis of Power Used for Various Purposes. (All Figures h.p. per 1,000 kw. of Main Plant.)

STATION	Feed Pumps.	Stoker and Economizer.	Fans.	Condensing Auxiliaries.	Coal and Ash.	General Services.	Total.
Lots Road, Chelsea	5	5	—	19	7	11	47
Carville	12	4	33	41	3	5	98
Greenwich	12	3.5	—	34	7	4.5	61
Glasgow— Port Dundas	11	3	21	37	5	3	80
Dunston	10	2.5	14	26	3	7	62.5
Glasgow— St. Andrew's Cross	9	3	8	78	5	2	105
Brighton	12	3.5	45	24	2.75	2.75	90
Hamburg Overhead	32	3	—	25	9	5	74
Markisches (Berlin)	22	1.5	12.5	25	7	2	70
Stepney	11	3.5	12	49	6.5	14	96
Newcastle and District	8	3.5	22	48	1	4.5	87
Cambridge	21	1	1	33.5	—	5.5	62
Alnwick	107	—	—	—	—	—	107
Morpeth	110	—	—	100	—	—	210

A LARGE CONCRETE VIADUCT.

In municipal districts where railroad tracks traverse thickly populated sections the question of proper accommodation for safe and uninterrupted traffic across the railroad property has become a serious matter. At Weston, a small municipality just to the immediate west of Toronto, the problem has been solved by the erection of the concrete and girder steel viaduct forming the subject of the accompanying illustrations.

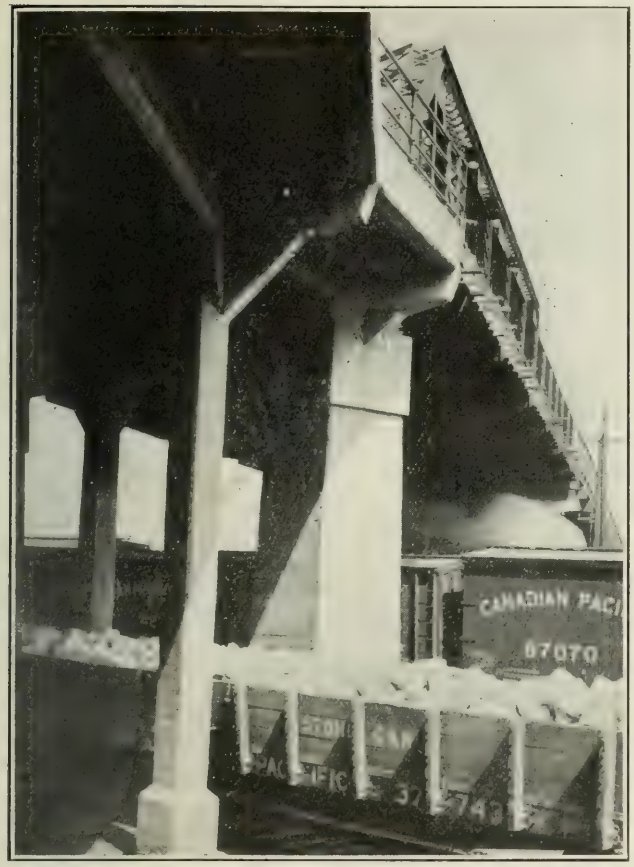


Fig. 1. View Showing Columns and Floor Beams.

A busy section of the main line of the Canadian Pacific Railway occupies the entire lower, open portions of the viaduct which, at this point is supported by a number of reinforced concrete piers. Leading to the spans an earthwork slope, held in place by a retaining wall of concrete, gives easy access to the higher parts of the structure. The entire length of the viaduct is almost 500 feet.

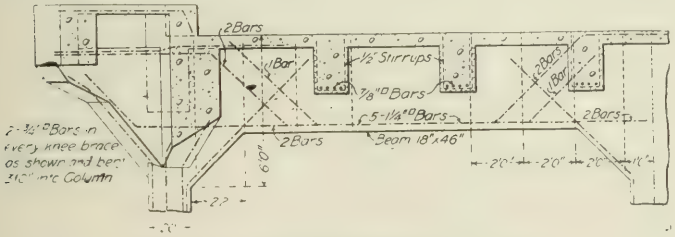


Fig. 2. Section through Bent Cap.

It is natural that the concrete columns supporting the central steel girder and bridge work should receive the major portion of the engineering attention. The footings for the columns were carried to a depth of 6 ft. below the ground level.; the area of the base being 64 sq. ft., stepped up to a 2 ft. by 2 ft. 4 in. area at the base of the columns. The columns are 16 × 20 in. reinforced by four ¾-in. bars, extending from the bottom of the footings up through the columns; at the top of which they are bent at an angle of 45 deg. passing through the floor-feams up into the floor slab. These bars are hooped with No. 12 gauge wire at 6 in. intervals.

The floor beams have a varying thickness, according to their position in the scheme, from a section of 16″ × 36″ to a section of 36″ × 50″. These beams are reinforced by four bars each.

The overhanging sidewalk and sidewalk supports are carried on cantilever arms reinforced with ¾-in. iron bars bent to the shape of the cement work which forms a right angle with the viaduct at the end of every floor beam. The sidewalk stringer is 12 × 24 in. and is reinforced with three ⅞-in. bars, two of which are bent up an angle of 45 deg., at each sidewalk bracket. The sidewalk is 4 in. thick and is reinforced with No. 16 gauge expanded metal. It is finished with a 1-in. facing of 1 part Portland cement, 1 part sand and 1 part screened gravel not exceeding ⅝ in. in diameter, which was floated to a smooth surface. The surface was marked off in blocks about 6 ft. in length and afterwards rolled with a patent roller.

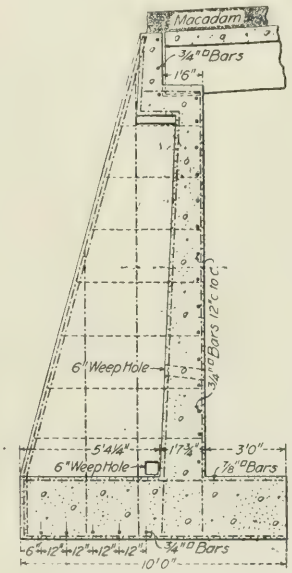


Fig. 3. Section Through Retaining Wall.

The bent supporting the steel span consists of two outer piers and a centre column. The outer piers are 6 × 6 ft. at the base, tapering to 5 × 5 ft. at the top and resting on footings each 10 × 10 ft. in area. These piers are reinforced with four ⅞-in. bars, one in each corner, and ½-in. stirrups spaced 12 in. on centres. The centre column is 20 × 20 in. with a base 2 ft. 4 in. × 2 ft. 4 in. × 2 ft. 8 in., resting on a footing with a base area of 8 × 8 ft. This column is reinforced with 4¾-in. bars hooped with No. 12 gauge wire.

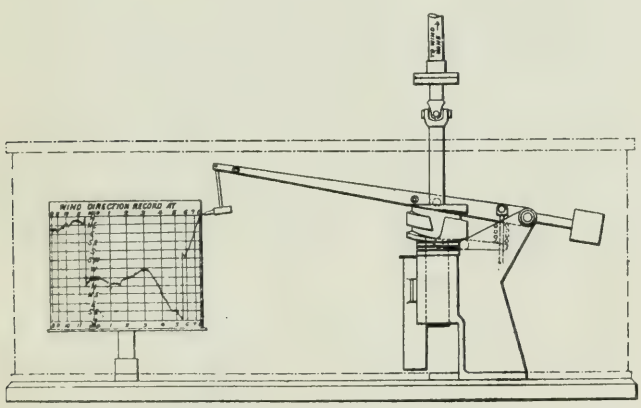
Fig. 4. View Showing Retaining Wall and Approach to Viaduct.

The sectional drawings, Figures 2 and 3, make clear the details of construction in the sloping approach. The footings of these walls from the lower end to the expansion

joints which are located 104 ft. from the lower end are 1 ft. 6 in. in thickness, increasing in width from 5 ft. to 7 ft. 4 in. and are reinforced with eight ⅝-in. horizontal bars, spaced as shown in the accompanying drawing, and ¾-in. transverse bars, spaced 12 in. centre to centre. At the expansion joint the footings are increased to 2 ft. 4 in. in thickness and widen it to 10 ft. at the abutment, at a distance of 120 ft. This portion is reinforced with five ¾-in. longitudinal bars and ⅞-in. transverse bars placed 12 in. centre to centre. The lower section of the retaining wall, 104 ft. long, is designed as a simple reinforced concrete wall, while the upper section, 120 ft. long, is designed with counterforts. Both sections are reinforced with a double system of rods, When the structure has taken a more finished appearance the earthwork will receive a coating of macadam pavement and by this means there will be completed a substantial road bed over the entire traffic way. The cost of this viaduct is estimated at $25,218. The contractor was Mr. C. E. Lewis, of Toronto, and the work was designed in the bridge department of the city engineer's office.

A WIND-DIRECTION RECORDER.

The wind-direction recorder which is shown in the accompanying figure, and was described in a recent issue of London Engineering, forms an example of a singularly simple solution of an awkward problem. The instrument, as will be gathered, consists of a pen which moves in a vertical plane, and traces a recording curve on the surface of a revolving drum. The pen is driven from a cam which is connected up to and actuated by a wind-vane, while the drum is driven by self-contained clockwork. The wind-vane is not



Diagrammatic Sketch of Recorder.

shown in the figure. It is mounted at the top of the vertical spindle, which is made of such length as may be necessary to enable the vane to be situated in an exposed position above the building in which the instrument is placed. Wind-direction recorders of other types than the present have, of course, been constructed. In one of these the chart is connected to the drum, and the pen is driven by clockwork, while others use two pens in various ways. The advantage of the present type lies in its extreme simplicity and in the fact that the movements of the pen are vertical and the charts rectilinear. It is obvious that an instrument having a simple and continuous groove in the cam could not be constructed on the lines of the figure, since with backing and veering winds the vane, after making a complete revolution, would cause the pen to so alter its zero in reference to the chart that the readings would become meaningless. In other words, if the vane is to be free to make complete revolutions in any direction—and this is, of course, essential—then there must be, at some point, a means of re-setting the pen on the chart. The simple method which has been devised for this purpose forms the main point of interest of the recorder under notice. As will be seen from the figure, the cam groove is in the form of a spiral, so that as the vane moves round, one way or the other, with a wind of varying direction, the pen either rises or falls on the chart. The zero adjustment is arranged for by the vertical slots at the ends of the cam groove, one of which can be seen in the figure. If, owing to continuous progression in one direction, the roller on the pen lever reaches one end of the spiral groove, it immediately moves through the vertical slot into the upper, or lower, part of the groove, as the case may be. The effect of this is naturally to trace a vertical line on the revolving chart, and at the same time to alter the zero of the pen. The chart, as will be seen, has a portion of its direction scale duplicated, so that after this vertical movement, the pen still indicates correctly the direction in which the wind is blowing. The instrument produces a broken curve of the type shown in the figure, but it is clear that such a curve presents no difficulties in reading. The details of the instrument are well shown in the figure. The pen lever is counterweighed and is also controlled by a spring. Its downward movement, when its roller travels in the vertical slot in the side of the cam remote from that shown in the figure, is brought about by its own weight; while its upward movement, when its roller is in the slot shown, is brought about by the spiral spring, which is compressed at the right moment by means of a lower lever, which has a roller working on the underside of the cam. This underside of the cam is formed to engage the roller of the second lever only when required. The pen lever is fitted up with a dashpot to prevent shock when it makes its quick vertical movements. The instrument is manufactured by Messrs. Negretti and Zambra, of 38 Holborn Viaduct, London, E.C.

MILLION-DOLLAR DAM.

According to a statement of Mr. A. S. Dawson, chief engineer of the department of natural resources of the Canadian Pacific Railway, Calgary, contracts have been let for a million-dollar work on the irrigation block. This includes a concrete aqueduct to cost half a million, other concrete structures to cost $300,000, and thirty steel bridges to cost one hundred thousand. The aqueduct is the first of its design to be constructed. It will be ten thousand five hundred feet long, with a maximum height of fifty-five feet, and will irrigate one hundred thousand acres of the Canadian Pacific block. The contract is awarded the Grant-Smith Company & McDonnel of Vancouver.

PLATINUM AT NELSON, B.C.

The investigation of the Geological Survey as to the platinum discoveries reported in Nelson last summer shows there is no foundation whatever for the statements then made that metals of the platinum group occur in the dykes in which they were reported. Two of the most reliable assayers who handled samples of the supposed platinum bearing dykes stated that they were unable to get even a trace, and their reports are now confirmed by the Geological Survey, as in all the samples taken by Mr. Leroy no platinum whatever was found with the exception of a doubtful trace in one sample.

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TORONTO BUILDING BY-LAW.

The revision of the Toronto building by-law is nearly completed. It will be remembered that in May, 1911, a Citizens' Committee, composed of representatives of the technical and business organizations of the city, presented a memorial to the Mayor and the City Council, asking for a general revision of the by-law, and suggesting along what lines the revision should be done. The draft by-law for regulating reinforced concrete construction is now complete, and has been submitted to the Citizens' Committee for their opinion. A copy of the by-law will be found in this issue of *The Canadian Engineer*. The Citizens' Committee states that, in the main, the by-law as revised is acceptable. The committee offers a number of comments covering certain minor points on which the by-law is excessively severe. It must be said that the Citizens' Committee has secured a vast improvement in the conditions of the old by-law. The useless and prohibitive restrictions on reinforced concrete construction in the original regulations are, many of them, struck out, or so modified that the by-law as it now stands is a workable instrument; while severe, it is not excessively or unfairly so. It is unlikely that any further change will be made in the draft as published. With restrictive legislation against reinforced concrete construction reduced to a fair competitive basis, there is no question that there will be a great impetus in the number of buildings of this type which will be erected in Toronto in the future. The revision comes too late to have much effect on the building industry this year, but next season will undoubtedly show a great increase in the number of reinforced concrete buildings erected.

THE REPORT OF THE TORONTO WATER COMMISSION.

The report of the Commission appointed to investigate the question of Toronto water supply has at last been published. An abstract of the report will be found in this issue of *The Canadian Engineer*. On the whole, the recommendations made are what were expected. The Commission has taken a definite stand against Lake Simcoe water and in favor of Lake Ontario as a source of supply. Taking this view, naturally their decision is in favor of Scarboro' as a point of local supply on account of prevailing currents, etc. They mention, however, the possibility of an auxiliary lake supply later from the west of the city. One feature of the report which merits commendation is the emphasis placed on the prevention of waste by means of meters. We have in these columns emphasized the necessity of taking measures to prevent the criminal waste of water going on in Toronto, and it is high time steps were taken, either by the installation of meters or the organization of an efficient inspection department to cut down this waste. The present plant on the Island is to be retained, and it is recommended that the intake pipe and the filtration plant there be duplicated. The Commission reasons that on account of the already large outlay on the Island plant that it would be uneconomical and unnecessary to abandon it. We must confess that we find it hard to understand why the Commission recommends

slow sand filtration at the Island and mechanical filtration at Scarboro'. If one method is good in one place, why is it not good in the other? The water at both locations is Lake Ontario water, with little difference in quality and conditions of turbidity. If the slow sand filtration plant at the Island is not as good as the mechanical filtration plant at Scarboro' will be, why duplicate the present installation? The Commission may have good reasons for their recommendations, but these reasons have not been given in the report.

The report recommends an emergency chlorination plant in connection with the plant at Scarboro', at which it will be possible to chlorinate either before or after filtration. To avoid interruption of service, they recommend another independent source of electric power other than Niagara. It is an open question whether an auxiliary power plant, either steam, oil or gas, should not be provided rather than another electrical supply. The difficulties of electrical supply are mainly in the transmission systems, and a storm which would cause interruption of service on the Niagara line would probably have a similar effect on any other line.

RAILWAYS AND THE PEACE RIVER REGION.

The progressive railway policy in Alberta, planned by Premier Sifton, has again drawn attention to the possibilities of the Peace River country. The trend of settlement in Canada, and also in the United States, has been westward, following the construction of railways. As the land in the railway belts (the more southern part of Western Canada) is being rapidly filled, as the older railway lines throw out their feeders northward, and, as the location and construction of the new National Transcontinental Railway proceeds, attention is being attracted to the great northern reserves.

The two sections next likely to receive the greatest attention from capital and immigration are Northern Ontario and the Peace River district. We have previously discussed in these columns the possibilities of the former. Even the little known about the fertile Peace River country creates substantial hopes of future development.

At a point some 400 miles due north of Edmonton, for instance, splendid crops of wheat, barley, oats, peas, etc., have been regularly raised for over twenty years, the product for the season of 1906 being 25,000 bushels. That the production of grain in these northern, sparsely-settled regions has already resulted in the establishment of local grist mills of considerable capacity, which manufacture flour by modern processes. Potatoes and other vegetables have been for many years satisfactorily cultivated at Fort Good Hope, on the Mackenzie River, fourteen miles from the Arctic circle.

Vegetation matures quickly in northern latitudes, owing to the long days during the season of growth. According to a statement made to the Senate Committee, which took evidence regarding the unexplored regions of the Dominion in 1907, there is in the Peace River section as much good agricultural land fit for settlement, and yet unsettled, as there is settled in Manitoba, Saskatchewan and Alberta to-day.

Mr. J. K. Cornwall, an enthusiast regarding the Peace River region, considers the waterways of the Mackenzie watershed as the finest in North America. The most southern point reached by navigation on the Mackenzie watershed is at Fort McMurray, at the junction of the Clearwater and Athabaska Rivers, a point about 275 miles north, and a little east of Edmonton. The distance from McMurray to the Arctic ocean is approximately 1,600 miles. In all this distance, the connected waterways are navigable for steamers that are now plying upon them, and have been for twenty years. There are in this long system of waterways two distinct divisions.

The Peace River practically passes through the centre of the vast Peace River district, and in the development of this district will always play an important part, as navigation is practically without a dangerous rapid or obstacle of any kind throughout its whole course, with the exception of one at the Vermilion Chutes.

As to the number of months in the year that this stretch of waterway in the Mackenzie basin is open for navigation, Mr. Cornwall says that all the rivers running to the north, and each with their source in the Rocky Mountains, namely, the Athabaska, the Peace and the Liard, "go out" between April 20th and May 1st, on the average. They are all navigable a week after they go out, but where these rivers enter the lakes the navigation opens later, it being not much before the first week in June, when the lake ice breaks up and disappears. Navigation is opened on an average about the middle of June.

This waterway runs through a country of great natural resources. Timber, asphaltum, copper, salt and fish are some of its natural resources. The agricultural possibilities of the Peace River district are unsurpassed in the North-West. Flour is ground at Fort Vermilion, which is 670 miles north of the United States boundary, and is in latitude 58.30. The Hudson Bay Company has a large and excellently equipped flour mill there which cost $45,000.

As progress is made in the Alberta government's railroad programme, we shall hear much more regarding the Peace River region, rich in possibilties and natural resources.

EDITORIAL COMMENT.

If it is true, as reported, that Mr. K. L. Aitken, the managing engineer of the Toronto Hydro-Electric Commission, will not return to take up his duties after his six months' leave of absence, it looks to us as if the Commission were making Mr. Aitken the scapegoat for the troubles they see looming up, and which they are primarily responsible for. We have had occasion to criticize the Toronto Hydro-Electric Commission before, and we feel that it is not too late even yet to replace the present Commission with one more thoroughly in touch and in sympathy with the Ontario Hydro-Electric Commission.

* * * *

In the inquest being held over the collapse of the Neilson building in Toronto the testimony of the witnesses has been of considerable interest. We do not care to comment on the accident until the inquest is closed. The evidence of the Assistant City Architect as given on Monday last, however, shows a most remarkable lack of appreciation of the eccentric loading of walls, and his evidence throughout has been conspicuous in his misunderstanding of the terms, "factor of safety" and "safe load."

REPORT ON TORONTO WATER.

During the latter part of 1910 and early in 1911, serious conditions developed in connection with the water supply of the city of Toronto. These conditions were, apparently, due to the failure of the seventy-two inch steel intake pipe, which partly filled with sand, thus cutting off the lake supply from the city. During the month of February, 1911, the city was compelled to fall back upon the Blockhouse Bay as its source of water supply. At this time the citizens were advised to boil all water used for domestic purposes.

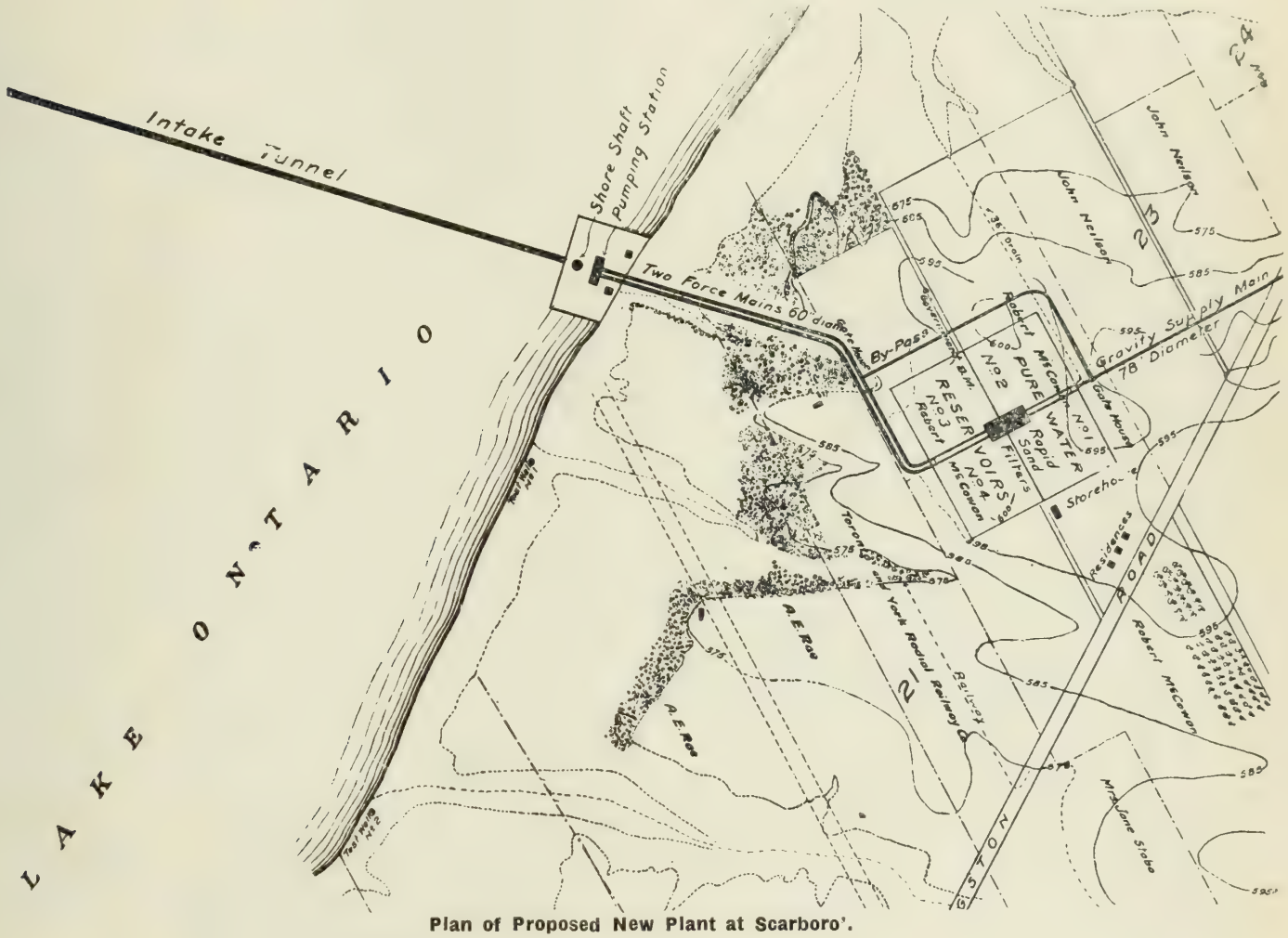
The chlorination plant, which had been in continuous operation since March, 1910, so purified the water, however, that there was no apparent increase in disease that could be attributed to the use of the Bay water. It was reasonable to conclude, however, that after the breaking up of the ice, the polluted harbor water might readily find its way to this temporary supply, and the advent of warm weather would increase the danger.

The waterworks department was then strenuously engaged in removing sand from the intake pipe in order to secure lake water at the earliest possible moment.

At this same time a sand filtration plant was under construction for treatment of the water supply.

The above circumstances, together with an acknowledged general feeling that the whole question of the present system of water and future requirements demanded immediate consideration, led the city council to ask for an independent examination and report. A board of consulting engineers was appointed, composed of Messrs. Isham Randolph, J. G. Sing, T. Aird Murray and W. Chipman, to consider the question, and they have now formulated and presented their report. An abstract of their report appears herewith.

A first interim report was presented to the Board of Control on March 24th. This report dealt exclusively with improving the supply, which was then being drawn from Blockhouse Bay, as it did not appear that Lake Ontario water could be obtained through the intake pipe for some considerable time. It was recommended that "Long Pond" be converted into a settling basin by constructing three dams on the harbor or city side leading from the harbor, and that a cutting be made to Lake Ontario at Clandeboye Avenue, across the Island, in order to introduce lake water into the pond. This report was adopted and the work immediately proceeded with, but it was not until May 10th that it was completed, from which time to June 29th, the city supply was drawn from the lake by way of Long Pond.



Plan of Proposed New Plant at Scarboro'.

For the first three months the greater part of this board's time was occupied with problems connected with protecting the temporary city supply from contamination while repairs were being made to the intake pipe, and in designing a new duplicate intake pipe to ensure a constant supply to the system.

Surveys, soundings, collection of and analyses of samples of water, and compilation and study of data, have been in almost continuous progress since the appointment of this board. Two test wells were also sunk on the beach at Scarboro' to determine the character of the underlying strata, about which there existed conflicting opinions.

The recommendations and estimates of cost with reference to a supply of water from Scarboro' are here given.

Recommendations and Conclusions.—(a) That the present and future source of water supply for the city of Toronto must depend solely upon Lake Ontario.

(b) That bacteriological, chemical and visual examinations of Lake Ontario water from Mimico to Scarboro' Heights have demonstrated that there is no locality within ten miles from the north shore of the lake from which water can be drawn which will at all times present a safe supply, unless such water be subject to some form of purification Although it is also apparent, from the evidence gathered, that water in the immediate vicinity of the city is subject to a greater degree of impurity for longer periods than water at a distance. It is also concluded, from the evidence, that

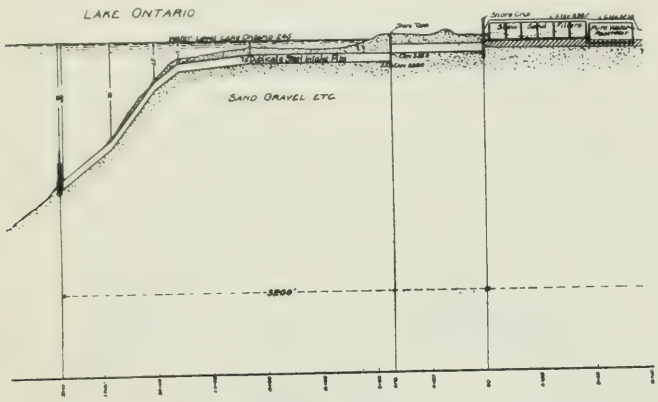


Diagram Showing New Intake Pipe.

the transporting lake currents are from the east to the west, and that there is a lesser probability of impure water to be met with off Scarboro' than off Mimico.

(c) That, taking into consideration the existing system, including filtration works, intake, conduits, tunnel under the bay, pumping machinery, large mains, and reservoir, it would be uneconomical and unnecessary to abandon it.

That the entire system should, however, be maintained in a proper condition of efficiency and each part or section brought up to a safe minimum capacity of at least sixty million gallons per day.

(d) That, by laying the duplicate intake pipe, now under contract, the duplication of the filtration plant, the connecting up of the sixty-inch steel conduit across the Island, and the installation of additional pumping machinery at John Street station, the existing system may be relied upon to supply sixty million gallons per day, and for a short period may meet a demand of ninety million gallons.

And that these proposed improvements be immediately undertaken, otherwise the city will undoubtedly be confronted with a water famine in the immediate future.

It is concluded that until the second intake be completed, Long Pond be retained in such condition that it may be converted into a settling basin for the city water supply upon twenty-four hours' notice.

(e) That all available evidence points to the necessity of increasing the water supply to meet the demands of one million population, and that it is not advisable to rely upon the present location for such increased supply. Taking into consideration the probable future rapid growth of the city, it is reasonable that the present location of supply be considered only as a central unit, and that extra units be installed either east or west of the central unit. That, owing to the demonstrated fact that purer water is obtainable for longer intervals of time east of the harbor than to the west, and owing to the high elevations of the plateau at Scarboro', a second unit be first installed at this location.

That all preliminary surveys, plans, etc., for the Scarboro' system be proceeded with immediately and works placed under contract.

It is concluded that, until Toronto can be assured of a second independent and reliable supply of water from the lake, what have been considered as exceptionable and unpreventible circumstances may again arise to the discomfort of the citizens and consequent lack of confidence in the organization of the waterworks department of the city.

The possibility that a third unit of supply may in the future be required to the west of the harbor, is admitted but not as yet anticipated.

(f) That, owing to the fact that the city is about to discharge its sewage into Lake Ontario at a point about two and one-half miles east of the harbor, it is of the utmost importance that the sewage be so treated that infectious matter be destroyed before being so discharged. That it is not apparent that the city is at present, by the proposed method, about to dispose of the sewage in a manner and to a degree which will insure a safe water supply from Lake Ontario in the vicinity of Toronto.

Improvements to Existing System.—In the interim report of November 30th a brief description is given of the improvements proposed to the existing system, together with an estimate of cost.

Protection works in connection with the old intake pipe were not fully completed in December last, and there exist grave reasons for doubting the stability of the old intake pipe, which was broken in February, 1911, and out of commission from that date until August. Dredging for the proposed duplicate intake progressed during the latter part of last season, but no pipes have yet been laid.

The filtration plant, with a nominal capacity of forty-five million Imperial gallons per day, was completed in December 1911, and by January 4th all of the filter beds were in operation. The pumping machinery, however, for lifting the water from the lake level to the filters has not the capacity specified, but this matter will probably be remedied by the contractors. The filtration pumping station is much too small for the machinery installed therein, and this board includes in the proposed improvements an extension of the filtration pumping station to the southward. Some of the machinery in the existing building may be moved into the

Sketch Showing General Proposed Extension.

extension proposed, and there should also be installed therein a second steam pumping unit and duplicates of the electrically operated machinery. It may not be necessary, at first, to double the capacity of the filters, but another pure water reservoir should be immediately constructed and a sufficient area of filters to meet the maximum demand for water that may be anticipated during the time that the Scarboro' project may be under construction.

The construction of the second reservoir will permit the existing one being emptied for cleaning, inspection and repairs. By the by-pass pipes shown, the contents of either

of the pure water reservoirs may be discharged into either of the conduit pipes. In case of accident to either intake, the arrangement shown will permit water being drawn from Long Pond to the filtration plant pumps and from thence passed through the filters and the second conduit to the tunnel.

A connecting pipe about 600 feet in length is to be laid from the sixty-inch conduit to the south shaft of tunnel, provided with valves at each end. This pipe is to be laid below the bed of the bay.

At the John Street pumping station the board recommends that a steam operated pumping engine of twenty-five million gallons capacity be added, or it may be advisable to substitute two fifteen million gallon units in lieu of one twenty-five million gallon unit. To accommodate this machinery it is proposed to extend the 1904 pump house westerly.

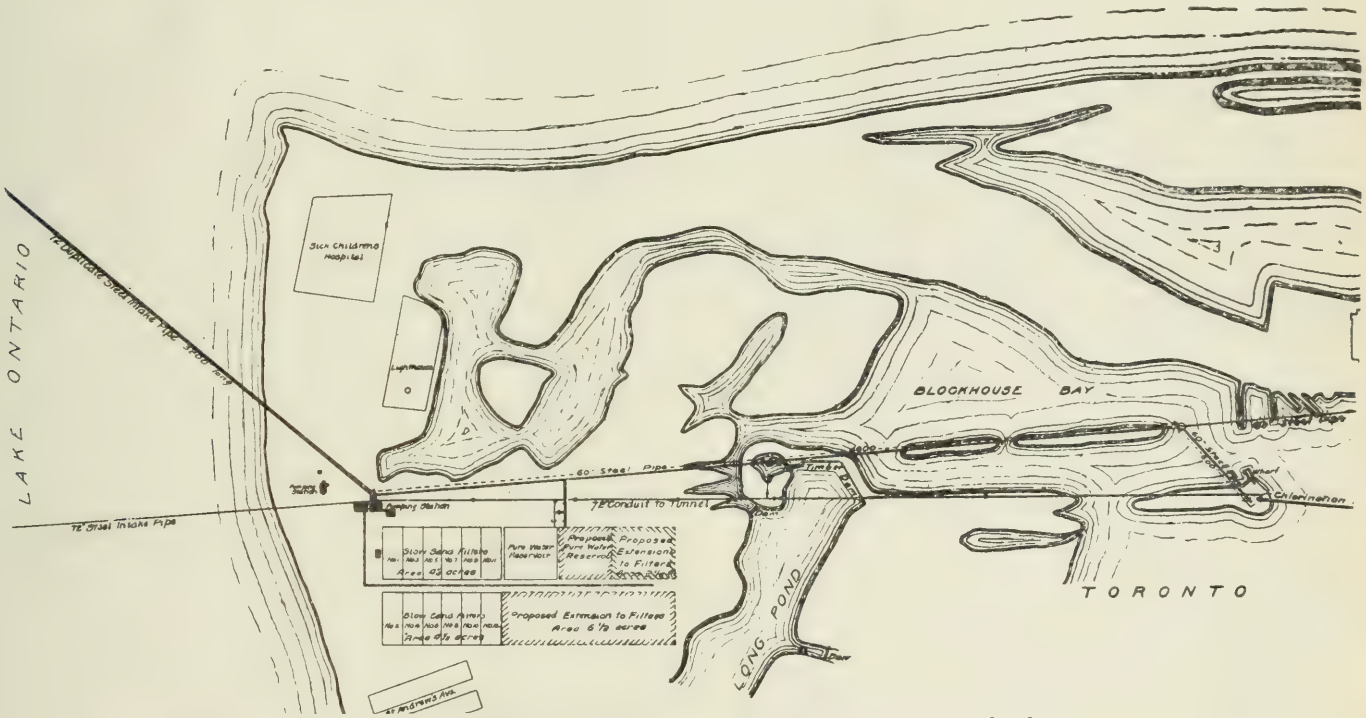
It would also now appear advisable to add two additional electro-turbine units each of not less than thirteen and one-half million gallons capacity.

If the electro-turbine units are added, and the two steam units substituted for the larger unit recommended, then the estimate of cost given in the interim report should be increased by $157,000, making a total of $1,287,000 exclusive of the duplicate intake pipe.

At Cleveland, Ohio, with Lake Erie as a source of supply, the general metering of the services was decided upon in 1901, at which time about six per cent. of the services were metered, the per capita consumption per day being one hundred and sixty-nine U.S. gallons, or one hundred and forty-one Imperial gallons. The reduction effected in the consumption was as follows:

Year.	Number of Services	Percentage Metered.	Gallons per Capita.
1901	55,130	6.42	169.40
1902	56,816	19.88	167.80
1903	58,852	42.81	141.60
1904	60,627	50.09	138.50
1905	64,137	69.70	130.80
1906	69,128	82.19	123.00
1907	72,225	88.60	117.50
1908	74,490	93.61	100.30
1909	76,777	97.48	93.64
1910	80,686	97.67	101.80

With fifty per cent. of the services metered the consumption was only reduced seven per cent.; with seventy-five per cent. metered the reduction was twenty-five per cent., and with practically all of the services metered, forty per cent. reduction.



Plan Showing Proposed Extensions to Present Plant on the Island.

The foregoing estimate will include a new forty-eight-inch force main from the pump house to Front Street, with connections to existing mains.

Waste Prevention.—The problem of waste prevention by the installation of meters, and efficient inspection, has not been considered in detail by this board, so far as Toronto is concerned, as it is understood that the city is taking up the question by means of a special committee. It is concluded, however, from the experience of this board, that the general metering of the domestic supply, with a minimum charge for each service, would reduce the per capita consumption by approximately one-third, and that the cost of installing the meters would be more than compensated for by the reduction in the cost of delivery. Furthermore, the existing plant could be made to supply a third more population than at present.

The main argument that is now urged against the adoption of meters is the cost of installation, and the maintenance charges. The argument that meters restrict the use of water has proven fallacious from experience, and may be dismissed.

As to the cost, the results at Cleveland are of value. At the end of 1910, 78,809 meters were installed, the cost of the meters and setting being $1,340,000, but this included several thousand meters in stock. The average cost of each meter set was about $17.50. The setting in the basement cost less than $4 each, and during recent years a larger percentage are being set in the basements. Of the eighty thousand meters over seventy thousand are on services five-eighths inches in diameter. The largest size of meters may be installed in brick chambers, but it will be found more economical and convenient to instal them in basements.

In Toronto, the cost of the meters would be higher than in Cleveland, also the cost of the setting, but as the great majority of the buildings in this city are of brick with proper basements and cellars, it would not be necessary to construct many brick vaults or chambers. To meter the entire city would cost approximately as follows:

60,000 meters set in basement, at $14	$840,000
10,000 meters set in vaults or chambers, at $30	300,000
Total	$1,140,000

The interest and sinking fund on the above amount may be estimated at $60,000 per year. At Cleveland the annual maintenance charges are less than thirty cents per meter. It may be assumed, therefore, that the maintenance charges in Toronto would be $20,000 per year. The depreciation may be taken at six per cent., or $66,000. This gives a total annual expenditure of $146,000 for metering.

By the report of the city engineer for 1910, Schedule 21, the cost of supplying water in Toronto is given for that year as five and three-quarter cents per thousand gallons, delivered to the consumer. This cost is the highest since 1894, the average for the twenty-six years being about five cents per thousand gallons.

The filtration plant constructed in 1910 and 1911, which has been in operation since January, 1912, will probably increase the cost of the water by three-quarter cents per thousand gallons, making a total of six and one-half cents per thousand gallons, or $65 per million for 1912.

The prevention of a waste of fifteen million gallons per day would, therefore, result in a total annual saving of $355,875. It is quite true that the cost of pumping and filtration is only two cents per thousand gallons, but the waterworks system must be considered as a whole, of which the pumping machinery and filtration plant is only a part. If more water is to be pumped through the mains, they must be increased in capacity or in numbers, and larger conduits will be necessary, as all parts of the existing system are now taxed to their full capacities in the summer months.

The general adoption of meters in the city of Toronto would probably result in a saving of $200,000 per annum.

Estimates of Cost of Specific Recommendations Made in Existing System.

(As Given in Interim Report No. 3.)

Duplication of Island filtration plant	$750,000
Lowering, repairing and connecting the sixty-inch conduit in Blockhouse Bay	50,000
One 25,000,000-gallon pumping engine	155,000
Three 200-h.p. boilers	20,000
Engine house and boiler house, complete	50,000
Engineering and superintendence, 10 per cent.	105,000
Total	$1,130,000

(Extra Expenditure not Given in Interim Report No. 3.)

Duplication of intake pipe	$333,000
Substitution two 15-million gallon pumping units for one 25-million gallon engine	40,000
Two electro-turbine units, each 13½-million gals. capacity	60,000
Additional boiler	7,000
Additional buildings	25,000
Force main, 48-in., across Esplanade to Front St.	10,000
Engineering and superintendence, 10 per cent.	15,000
Total additional	$490,000

Cost of meters:

60,000 meters set at $14	$840,000
10,000 meters set at $30	300,000
Total cost of metering	$1,140,000

Description of Proposed New Works.—The supply of water for the proposed new system is to be drawn from the lake at a distance of about two miles from shore, and opposite lot 16 in the township of Scarboro'. At this point the depth of water is about one hundred feet.

The proposed intake crib will be of reinforced concrete and steel, with a diameter of one hundred and ten feet at the base, and a height of about one hundred and fifteen feet. This crib will be sunk into the shale and clay of the lake bed, and the compartments filled with concrete. The inlet shaft will be sunk vertically from the centre of the crib to the elevation of the tunnel, from which point work on the tunnel will be prosecuted towards shore.

The interior of the crib will be an open cylinder about seventy feet in diameter, into which the water from the lake will flow through a number of ports at different elevations, controlled by valves, by means of which the supply may be drawn from any desired depth.

The crib is to be covered by a concrete and steel building surmounted by a small lighthouse for the guidance of vessels.

The proposed location of the intake crib is seven miles east from the effluent discharged from the Morley Avenue sewage disposal works, the existing water intake being five miles to the west. Furthermore, the transporting currents are westward rather than eastward, as pointed out in the observations upon the lake currents. All currents caused by easterly and south-westerly winds have a tendency to follow the shore line, consequently the greater the distance the intake be located from the shore, the less the turbidity.

At the point selected the turbid zone rarely extends one-half mile from shore; further, between Ashbridge's Bay and Highland Creek, there are no surface streams of any consequence discharging turbid water into the lake. The watershed adjoining the lake at Scarboro' presents a very limited area of land draining toward the lake, and can have practically no effect on its purity. A small amount of surface water now drains through a number of small water courses and gullies from the highlands to the shore. This area will, no doubt, become a residential section of the city, from which the domestic sewage may be conveyed by gravity to the main sewage disposal works near the Woodbine, while the greater part of the storm water may be diverted northward to the Don and Highland Creek.

From data obtained from the office of the Geological Survey, Ottawa, and other sources, the surface of the Hudson River geological formation was assumed to be at a depth of less than one hundred feet at the shore line at Scarboro'. Two test wells were sunk by this board on the beach, in each of which the surface of the rock was struck about fifty feet beneath the lake level. The depth at which the rock of the Hudson River formation is struck on the south side of Lake Ontario has been determined by borings, and the vertical distance to the top and to the bottom of the formation has also been determined at a few points along the north shore between Highland Creek and Mimico, from which it may be safely concluded that the Hudson River shales form the bed of the lake for some miles southward from the north shore, although the rock surface may be overlaid with a few feet of clay, sand and silt.

The intake crib is to be connected with the pumping station at the shore by a tunnel two miles in length and ten

feet interior diameter, to be constructed in the shale of the Hudson River formation at a depth of about one hundred and sixty feet below the lake surface, to avoid as far as possible the infiltration of water. At the shore end, a vertical shaft will be constructed one hundred and sixty feet in depth, through which the water will rise to supply the pumping machinery.

Before preparing detailed plans of the intake crib and tunnel, a sufficient number of borings should be made along the line of the proposed tunnel to determine accurately the surface of the Hudson River shales and the character of these shales for some feet in depth. This work can only be performed advantageously in the summer months, and should be proceeded with during the coming season.

At the shore end of the tunnel about five acres should be enclosed by a concrete breakwater, the interior space to be filled by materials excavated from the tunnel, and the surplus from the grading on shore.

Upon the site thus formed a pumping station is to be erected, also shop and residences for engineers, office, etc. The building may be of brick or reinforced concrete, fireproof throughout.

The pumping machinery will comprise four electrically operated high pressure turbine pumps, each of fifteen million Imperial gallons capacity per twenty-four hours. Three of these units should be installed at first, and space left for two or more additional units.

Electric current is to be transmitted to the new pump house from the municipal hydro-electric sub-station to be erected at the south-east corner of Gerrard Street and Carlaw Avenue, a distance of about eight miles. To avoid all possibility of interruption to the service, another independent source of electric power should be connected with the pumping station, preferably from the Trent Valley or some source other than Niagara.

From the pumping station two parallel rising mains of steel, each sixty inches in diameter, will convey the water to filtration works on the plateau above, the total lift being about three hundred and seventy feet. These two mains are to be laid on a grade not exceeding forty-five degrees at any point on the line, the total distance from the pump house to the filtration works being two thousand feet.

As the water supply off Scarboro' will be free from turbidity, excepting after heavy gales, and as the possibility of sewage pollution from the city will be less than at the existing intake, and as this pollution can only occur with strong westerly winds, the necessity of filtration may not at first be apparent; but, it should be borne in mind that bodies of infected water are floating in the lake, and to guard against the possibility of danger from this source, it is advisable that the water should at all times be filtered.

The board has concluded that a mechanical filtration plant will meet the requirements at Scarboro', and will cost less than a slow sand filtration plant similar to that on the Island.

The filter tanks or beds are to be constructed over the reservoirs.

A chlorination plant for emergency service is also to be provided in connection with the filtration plant, so located that the chlorine may be applied to the raw water or to the filtered water.

The capacity of the reservoir estimated upon will be one hundred and thirty million gallons, equivalent to twenty acres in area and twenty-five feet in depth. By subdividing the reservoir into four units, opportunity will be given for repairing and cleaning. The reservoirs will be constructed of reinforced concrete, and covered by a groined roof.

The outlet from the reservoir will be through two or more pipes leading to one supply main By means of by-pass pipes the supply may be pumped directly from the pumping station into the main leading to the city.

About forty acres of land will be required for the reservoir and filtration works, but this board recommends that one hundred and twenty acres be purchased, or all of lot 22 between Kingston Road and the lake. The pumping station and the rising mains will be located on lot 21, which adjoins lot 22 to the eastward.

Estimated Cost of Scarboro' Project.

1.	Intake tunnel, 10,560 lineal feet, 10 feet diameter	$633,600
2.	Shore shaft, 160 feet at $150, and lake shaft, 60 feet at $150	33,000
3.	Intake crib	500,000
4.	Pump house site, retaining wall	80,000
5.	Pump house	30,000
6.	Pumping machinery, 60 millions capacity (4 units, 15 each)	150,000
7.	Transmission line, 8 miles	48,000
8.	Rising mains, two 60-inch pipes, each 2,000 feet long	80,000
9.	Grading for and laying rising mains	20,000
10.	Land for filtration works, reservoir, etc., 120 acres, at $600	72,000
11.	Filtration works, mechanical filter, capacity 60 millions per day, machinery and laboratory	653,400
12.	Covered reservoir, 130 millions capacity	1,071,000
13.	Gravity supply main from reservoir to high level pumping station, 55,000 feet steel pipe (delivered)	880,000
14.	Excavating for, laying, and covering at $5 ..... $275,000 Tunnel at Castle Frank, 1,200 ft., at $25 extra ..... 30,000 Crossing River Don, extra 15,000	320,000
15.	Main from high level pumping station to West Toronto, 17,500 feet. 48-in., 42-in., and 36-in. (laid)	262,500
		$4,833,500
16.	Ten per cent. for contingencies, engineering, etc.	486,500
	Total estimated cost	$5,320,000

From the Scarboro' reservoir the water supply will gravitate to the city through a steel conduit, the diameter from the reservoir to East Toronto being seventy-eight inches, from East Toronto to the westerly side of the Don seventy-two inches, and from the last named point to the existing pumping station at Poplar Plains Road, the diameter may be reduced to sixty-six inches. This gravity main is to be laid along the concession road allowance westerly from the reservoir to the north side of the G. T. Ry., thence following the north-westerly side of the G. T. Ry. to Danforth Road, thence westerly along Danforth Road and Danforth Road produced, to the westerly side of the River Don, thence by a tunnel under the Castle Frank Hill to the Rosedale Ravine, thence along Rosedale Valley Road and McPherson Park to Yonge Street, thence via Ramsden Park, Peers Avenue, Avenue Road and McPherson Avenue, to the high level pumping station.

The pressure from this gravity supply main will be sufficient for all that portion of the city located south of the escarpment known as Wells Hill in the central part of the city, and all south of the easterly branch of the Don in the easterly part of the city. East Toronto area, now supplied by the intermediate service, and West Toronto, will thus be supplied from the Scarboro' reservoir by gravity. For the

higher districts, lying north of Davenport Road and the easterly branch of the Don, it will be necessary to repump the water required, and as this district is rapidly increasing in population, additions to the pumping machinery will be frequently demanded.

By the adoption of the Scarboro' scheme, all of the existing pumping machinery at Poplar Plains station may be used for the highest district, the intermediate district being served by gravity.

In the West Toronto district and the East Toronto district, it may be eventually found desirable to instal booster pumping stations for general service, but in the low level district and the intermediate district, it would be a mistake to increase the ordinary pressure materially for fire service, although in the out-lying districts it may be permissible to do so.

A large supply main is also to be laid from the intersection of Avenue Road and McPherson Avenue westerly along McPherson, Bridgeman, Main, Brandon, Kingsley, Pelham and Lyndon to West Toronto, this main to be forty-eight inches in diameter at McPherson, reducing to thirty-six inches at Lyndon.

It is estimated that the construction of the proposed Scarboro' works will take from three to five years to complete.

POWER SITES IN THE WEST.

Notwithstanding the various rapids, the North Saskatchewan River may be considered a navigable stream throughout its length from the head of the Grand rapids, near Lake Winnipeg, to Edmonton and beyond. For many years, it has been navigated by the Hudson's Bay Company's steamboats, which make one or two trips a year to carry supplies for the posts.

The Bow River rises in the watershed of the Rocky Mountains, and flows in a southeasterly direction until it reaches the foothill country at the "Gap." It then turns to the east as far as Calgary, and, thence, runs south and east to its confluence wih the Belly River. Between its source and the "Gap," a number of streams flow into it from the various mountain valleys that it intersects. Almost immediately after leaving the mountains it is joined from the south by the Kananaskis River, a stream of good size and fairly uniform flow, which has its source in the eastern ranges of the Rocky Mountains in muskegs and lakes lying at a considerable elevation. From this point to its confluence with the Belly River, the Bow furnishes the run-off channel for the eastern slope of the Rocky Mountains and is fed by numerous streams. It is broken in several places by falls and rapids. At Calgary, a hydro-electric plant, operating under a low head of 14 feet, derives its power from one of these. A large development at Horseshoe and Kananaskis Falls, where a head of 70 feet is obtained, is now completed.

Rising in the watershed range of the Rocky Mountains and receiving many glacial tributaries, the Athabasca River contains many valuable power sites between its source, at an altitude of about 5,000 feet, and its debouchement into Lake Athabasca at an altitude of 690 feet. Of these, the most noted are at the succession of falls and rapids known collectively as the Grand Rapids. As they can only be rendered navigable by canals, the question of interference with navigation does not require consideration.

The remarks respecting the Athabasca also apply in large measure to the Peace River. In addition to the power sites in the ranges west of the Rockies, there are two important sites on this stream. The upper is at Rocky Mountain portage. At this point the river is a raging torrent flowing 25 miles through a canon, and has a total fall of 270 feet. The lower is situated at Vermilion fall, the only interruption to navigation between its confluence with Slave River and above Dunvegan, a distance of upwards of 530 miles.

NEW BUILDING BY-LAW FOR TORONTO.

The text of the new by-law for Toronto regulating reinforced concrete construction is given below. Some slight changes may be made before the by-law is ratified by the City Council.

1. The term "reinforced concrete" as used in this by-law is to be understood to mean an approved concrete mixture reinforced by steel of any shape so combined that the steel will take up the tensional stresses and assist in the resistance to shear, and the construction must be of such a nature that the stresses can be calculated by the accepted formulas of modern engineering practice.

2. (1) Before permission to erect any reinforced concrete structure or any structure containing reinforced concrete is issued, complete drawings and specifications, signed by the architect or engineer who designed the structure and clearly showing all details of the proposed construction, and the size, shape and position of all reinforcing rods, stirrups or other forms or metal, also a certified copy of the computations of the architect or engineer showing how the strength of the different portions of the structure was arrived at, shall be submitted to the department of the city architect and superintendent of building for examination and approval, and when satisfactory, the approved signed drawings, specifications and static computations shall be filed in the said department until the completion of the work, provided, however, that permission to erect any reinforced concrete structure does not in any manner imply the acceptance of the work or relieve the architect or engineer who designed the structure from full responsibility for the actual construction.

(2) All reintorced concrete construction shall be performed under the personal and constant supervision of either a fully qualified engineer or competent superintendent.

(3) It shall be the duty of the engineer or superintendent in charge of the work to keep an exact record of the progress of each operation, which record shall clearly show the position of and give the date of placing of all concrete and the date of removal of forms, a certified copy of which is to be furnished the inspector of buildings weekly, and upon the completion of the work the correctness of the records, which have been furnished weekly, to be certified to and sworn to, if considered desirable, by the person under whose constant supervision the work was carried out.

(4) Inspection by the engineer or superintendent in charge shall cover the following:

(a) The materials;

(b) The correct construction and erection of the forms and supports;

(c) The sizes, shapes, arrangement and fastening in position of all reinforcements;

(d) The proportioning, mixing and placing of the concrete;

(e) The strength of the concrete by tests of standard test pieces made during the progress of the work;

(f) Whether the concrete is sufficiently hardened before the forms and supports are removed;

(g) Prevention of injury to any part of the structure by and after the removal of the forms;

(h) Comparison of dimensions of all parts of the finished structure with the plans.

(5) The execution of reinforced concrete work shall be confided to workmen accustomed to this class of construction who shall be under the control of a competent foreman, and it is to be distinctly understood that under no conditions will the engineer or superintendent in charge of the work be permitted to act in the dual capacity of both inspector and foreman.

Forms.—3.—(1) All forms shall be built rigid, plumb and true, thoroughly braced and with tight joints so that no appreciable part of the concrete mixture can escape, and their interior dimensions must conform to the dimensions of the concrete sections shown upon the approved plans. All forms shall be supported so as to carry the dead load of the construction as a liquid without spring or deflection, and any form that becomes twisted or warped shall be correctly adjusted before concrete is placed therein. Building paper will not be allowed in forms for any purpose whatsoever.

(2) If forms are to be hung from steel beams the hangers and the method of hanging shall be subject to the approval of the inspector of buildings, and no hangers that are difficult to remove shall be used.

(3) The forms for beams, girders and lintels shall be so designed that at least one side of each beam or girder may be removed without disturbing the bottom portion of the form or its supports.

(4) All posts supporting forms for slabs, beams or girders must rest upon wedges which can be loosened and removed without producing undue strains in the floor or roof system.

(5) Posts which are to be supported from the ground must be provided with footings of sufficient area to do away with any liability of appreciable settlement owing to insufficient foundation.

(6) All column forms shall have an opening left at the bottom to enable cleaning out and adjustment of the steel to be attended to, which opening is not to be closed until the column is to be poured.

(7) All shavings, chips, sawdust, ice or other foreign matter must be removed from within all forms before concrete is placed therein.

Cement.—4.—(1) Only Portland cement will be accepted in reinforced concrete construction and this cement must comply in all respects with the requirements of the standard specifications of the city engineer's office of the city of Toronto, which are as follows:

(a) The specific gravity of the cement shall not be less than 3.10. Should the test of cement as received fall below this requirement, a second test may be made upon a sample ignited at a low red heat. The loss in weight of the ignited cement shall not exceed 4 per cent.

(b) It shall leave by weight a residue of not more than 8 per cent. on the No. 100 and not more than 25 per cent. on the No. 200 sieve.

(c) It shall not develop initial set in less than thirty minutes and must develop hard set in not less than one hour, nor more than ten hours.

(d) The minimum requirements for tensile strength for briquettes one square inch in cross section shall be as follows, and the cement shall show no retrogression in strength within the periods specified:

Age.	Neat Cement.	Strength.
24 hours	in moist air	175 pounds
7 days	(1 day in moist air, 6 days in water)	500 "
28 days	(1 day in moist air, 27 days in water)	600 "
	One part cement, three parts Standard Ottawa sand.	
7 days	(1 day in moist air, 6 days in water)	200 "
28 days	(1 day in moist air, 27 days in water)	275 "

(e) Pats of neat cement about 3 inches in diameter one-half inch thick at the centre and tapering to a thin edge shall be kept in moist air for a period of 24 hours.

(f) A pat shall then be kept in air at normal temperature and observed at intervals for a least 28 days.

(g) Another pat shall be kept in water maintained at as near 70 degrees F. as practicable and observed at intervals for at least 28 days.

(h) A third pat shall be exposed in any convenient way in an atmosphere of steam above boiling water in a loosely closed vessel for 5 hours.

These pats to satisfactorily pass the requirements shall remain firm and hard and show no signs of distortion, discoloration, checking, cracking or disintegrating.

(i) The cement shall not contain more than 1.75 per cent. of anhydrous acid (SO_3) nor more than 4 per cent. of magnesia (MgO).

(2) No cement shall be used in any reinforced concrete work unless it has been tested either at the manufactory or at some acceptable laboratory and a certified report of the test filed with the inspector of buildings.

(3) All such tests shall be made in not more than carload lots or in smaller quantities if so directed by the inspector of buildings, and when laboratory tests are to be made the cement shall be delivered at the job at least two weeks before it is required for use so as to allow ample time for testing.

(4) Proper care is to be taken to separate lots delivered so that they can be easily identified if found unsatisfactory, and a suitable place must be provided for the storage of all all cement. No cement shall be used that has absorbed sufficient moisture to cause it to granulate or become lumpy when thoroughly dried.

(5) Any cement without the makers' name and brand on the barrel or package will be rejected without test, as will also any cement in barrels or packages bearing other than the makers' name and brand.

(6) The inspector of buildings may require a certificate from the manufacturer to the effect that the cement has been seasoned or subjected to aeration for at least thirty days before leaving the works.

(7) All tests shall be made at the expense of the contractor, and all cement or other rejected material must be immediately removed from the job and the vicinity.

Aggregates.—5.—(1) Extreme care shall be exercised in selecting the aggregate for mortar and concrete and careful tests must be made where any doubt exists of the materials for the purpose of determining their qualities and the grading necessary to secure maximum density or a minimum percentage of voids.

(2) Fine aggregates shall be uniformly graded from coarse to fine and consist of sand, crushed stone or gravel screenings, passing when dry, a screen having one-quarter inch diameter holes, and not more than six per cent. passing a sieve having 100 meshes per lineal inch. It shall be of clean silicious material free from vegetable loam and other deleterious matter.

(3) Mortars composed of one part Portland cement and three parts fine aggregate, by weight, when made into briquettes, shall show a tensile strength of at least 70 per cent. of the strength of 1:3 mortar of the same consistency made with the same cement and standard Ottawa sand.

(4) Coarse aggregate shall consist of inert material such as crushed stone or screened gravel which is retained on a screen having one-quarter inch diameter holes. The particles shall be clean, hard, durable and free from dust or other deleterious material, and the maximum size shall pass in any direction through a one inch diameter ring. A graduation of the size of the particles from fine to coarse will be considered advantageous.

(5) Samples of all aggregates must be submitted to the inspector of buildings and his approval of them obtained before being used in any work.

Reinforcement.—6.—(1) All steel used for reinforcement shall be medium steel made by the open hearth process,

and be rolled from new billets. No re-rolled steel will be allowed. The steel shall have an ultimate tensile strength of not less than 60,000 pounds per square inch of net cross section, and an elastic limit of at least one-half of this ultimate strength, and for sizes up to ¾ inch in diameter shall bend cold 180 degrees around a diameter equal to the thickness of the piece tested without sign of fracture on the outside of bent portion.

(2) For sizes greater than ¾ of an inch in diameter it shall bend cold 180 degrees around twice its own diameter without sign of fracture on the outside, except in cases where all bends necessary in the construction are to be made hot, in which case the steel shall bend cold 90 degrees around its own diameter without sign of fracture.

(3) All material tested to destruction shall show a uniform silky fracture and all reinforcing steel shall be free from checks, cracks, flaws or other imperfections, also free from paint, oil, dirt, grease or heavy rust or scale.

(4) If deformed bars are used only the net section—the section exclusive of all projections—of the area of such bars shall be considered effective.

(5) Tests of the steel proposed to be or being used in any reinforced concrete structure shall be made at the expense of the contractor upon the request of the inspector of buildings, and such tests shall be made at a place satisfactory to him and under the supervision and direction of the architect, engineer or superintendent in charge of the work.

(6) A certified copy of the report of all such tests to be filed with the inspector of buildings immediately after being made.

Mixing.—7.—(1) The ingredients of concrete shall be thoroughly mixed dry after which the proper amount of water shall be added and the mixing continued until the cement is properly distributed and the mass uniform in color and homogeneous.

(2) Methods of measurement of the proportions of the various ingredients, including water, in each batch shall be used which will secure separate uniform measurements at all times. The use of boxes especially constructed for the purpose will be preferred, but the use of iron wheelbarrows may, with the consent of the inspector of buildings, be used for measuring stone and sand.

(3) All concrete materials shall be measured loose.

(4) All concrete must be machine mixed using a batch mixer of an approved design if the amount of concrete in the work exceeds fifty (50) cubic yards. Continuous mixing machines will not be allowed.

(5) A competent foreman must be in constant attendance at the mixer to give his approval of every batch which leaves the machine.

(6) When the amount of concrete does not exceed fifty (50) cubic yards, the mixing may be done by hand on a smooth watertight platform not less than fourteen feet by twelve feet square, and having a raised rim around the edge at least three inches in height. The fine aggregate shall be first evenly spread on this platform and the proper proportion of cement shall then be spread over the aggregate when the ingredients shall be thoroughly mixed with hoes or shovels, then spread out evenly over the platform while in a dry state. Clean water shall then be applied and the cement and fine aggregate thoroughly mixed until a mortar of the proper consistency is formed which shall be evenly spread over the platform. The stone or gravel after being wetted shall then be evenly spread over the mortar and the whole mass thoroughly mixed with shovels and hoes by being turned over and worked at least three times, not counting the shovelling off the platform. No more than three-quarters of a cubic yard shall be mixed in any one batch.

(7) The materials must be mixed wet enough to produce a concrete of such consistency as will flow into the forms and about the metal reinforcement and which at the same time can be conveyed from the mixer or platforms to the forms without separation of the coarse aggregate from the mortar.

(8) Retempering mortar or concrete, i.e., remixing with water after it has partially set, will not be permitted.

Placing Concrete.—8.—(1) Concrete shall be deposited in the forms as rapidly as possible after leaving the mixer, and under no circumstances shall concrete be used that has attained initial set before final placing, nor shall such concrete be returned to the mixer.

(2) When placing concrete is once started it shall, if possible, be carried on as a continuous operation until pouring of the section or panel is completed.

(3) When being deposited or poured the concrete shall be agitated continuously with suitable tools such as a straight shovel or slicing tool kept moving up and down until all the ingredients have settled to their proper place by gravity, and the surplus water has been forced to the surface. Filling the forms completely and puddling afterwards will not be permitted. In placing the concrete the work shall be so laid out that the partly set concrete shall not be subjected to shocks from men hauling or wheeling material over it.

(4) Before placing concrete care should be taken to see that the forms are constructed as hereinbefore specified for and thoroughly wetted, and the space to be occupied by the concrete free from debris.

(5) When the placing of concrete is suspended all necessary grooves for joining future work shall be made before the concrete has had time to set. When work is resumed concrete previously placed shall be roughened, thoroughly cleansed of foreign material and laitance, drenched and slushed with a mortar consisting of one part Portland cement and not more than two parts of fine aggregate.

(6) Care must be taken to stop work at such a point that the joint formed when the work is resumed will have the least possible effect on the strength of the structure. Footings shall be cast to their full depth at one operation.

(7) Construction joints in beams and girders shall be vertical and at a point midway between supports, unless a beam is located at this point, in which case the joint shall be offset at a distance equal to twice the width of the beam.

(8) Construction joints in slabs shall be near the centre of the span. No joint will be allowed between slab and beam or girder.

(9) Any concrete which may run past the bulkheads must be cleaned up and removed before the concreting of the next section is started.

(10) Where brackets are used the brackets will be considered a part of the beam or girder.

(11) All columns are to be poured a sufficient length of time ahead of the floor construction to allow the concrete in the column to properly set up. The pouring of a column must be in one continuous operation to the bottom of the beam or girder is supports and during the pouring the concrete shall be well stirred or puddled with a long rod or tamp to expel all bubbles of air and prevent voids and honeycombing. Joints in columns shall be perpendicular to the axis of the column.

(12) In slab construction the finish must be laid integrally with the rest of the slab or it will not be considered as part of the slab in calculating the strength of same.

(13) Whenever possible the edges of girders, beams and columns shall be chamfered and the sides of beams and

girders splayed in order that the forms may be more easily removed.

(14) All reinforcing steel shall be accurately located in the forms and secured against displacement and the lateral spacing of the steel in lintels, beams or girders shall not be less than two and one-half diameters centre to centre.

(15) No concrete shall be poured until the engineer or superintendent in charge has examined the particular section in which it is desired to proceed with this portion of the work and has expressed himself satisfied with the structural condition and cleanliness of the forms and the placing, splicing and fastening in its proper position of the steel reinforcement.

(16) When concreting is carried on in freezing weather, the material must be heated and such provisions made that the concrete can be put in place without freezing. The use of frozen, lumpy sand or stone depending on hot water used in mixing to thaw it out will not be permitted.

(17) All concrete shall be kept at a temperature above freezing until it has thoroughly hardened, and all concrete which is frozen shall be removed.

(18) Concrete placed in warm weather, or which from any other cause is exposed to premature drying, shall be kept thoroughly wet during the first week after being put in place.

(19) Concrete shall not be placed in water unless unavoidable, but when this cannot be avoided, unusual care must be exercised to prevent the cement from being floated away, also the formation of laitance. The concrete shall also be deposited through a metallic tube or from a bucket having a bottom dump, and care shall be taken to keep the suiface of the concrete as nearly horizontal as possible. The proportion of cement in concrete deposited under water. shall be 25 per cent. in excess of that required for similar work deposited in the ordinary way.

Removal of Forms.—9.—(1) Forms shall not be removed until the concrete is thoroughly set and is of sufficient strength to carry its own weight together with whatever live load is liable to come on the construction.

(2) No form shall be removed without the approval of the architect or engineer or the superintendent in charge of the structure.

(3) The original supports for beams and girders must remain in place for at least twenty-one days after the concrete has been poured and before these supports are interfered with, the entire forms must be removed from supporting columns and the sides of beams and girders stripped so as to enable a thorough examination of the concrete to be made.

(4) The form shall not be removed from columns in less than six days, and forms supporting floor slabs shall not be removed in less than ten days after the concrete has been poured. The sides of forms for beams and girders may be removed at the same time as the forms supporting the floor slabs.

General Assumptions.—10.—(1) As a basis for calculations for the strength of reinforced concrete construction the following assumptions shall be made:

(a) A plane section before bending remains plane after bending.

(b) The modulus of elasticity of concrete in compression within the usual limit of working stresses is constant.

(c) In making calculations the tensile stress of concrete shall not be considered.

(d) The steel shall take all the tensile stresses.

(e) Perfect adhesion is assumed between concrete and reinforcement. Under compressive stresses the two materials are, therefore, stressed in proportion to their moduli of elasticity and their distance from the neutral axis.

(f) The ratio of the modulus of elasticity of steel to the modulus of elasticity of concrete shall be assumed to be fifteen for concrete with a crushing strength of 2,000 pounds per square inch after hardening for 28 days.

(g) Initial stress in the reinforcement due to contraction or expansion in the concrete may be neglected.

(2) The span length of beams and slabs shall be taken as the distance from centre to centre of supports, but shall not be taken to exceed the clear span plus the depth of the beam or slab. Brackets shall not be considered as reducing the span.

(3) The dead load shall include the weight of the structure and all fixed loads and forces.

(4) The live load shall include all loads and forces which are variable.

(5) The weight of reinforced concrete shall be taken as 150 pounds per cubic foot.

Bending Moments.—11.—(1) The bending moment for slabs and beams, when not continuous over supports, shall be taken at not less than $\frac{WL}{8}$.

(2) When slabs and beams are built continous over two or more supports, the bending moment shall be taken at not less than $\frac{WL}{10}$.

(3) When slabs and beams are continuous over one support only, the bending moment shall be taken at not less than $\frac{WL}{9}$.

(4) In the case of square panels reinforced in both directions and continuous over all supports, the bending moment of the slab shall be taken at not less than $\frac{WL}{20}$ provided, however, that when square floor slabs reinforced in both directions are continuous to walls, the bending moment of the slab shall be taken at not less than $\frac{WL}{18}$.

W = Total uniformly distributed load.

L = Span of beam or slab.

(5) The length of a slab in which reinforcement in both directions will be allowed for is limited to one and a half times the width. The proportion of load on a slab up to this limit which will be considered as being transferred to the side and end supports will be that obtained by using the following formulas:

(a) Load on longer supports $= \frac{L^4}{L^4 + B^4}$

(b) Load on shorter supports $= \frac{B^4}{L^4 + B^4}$

L = Length of span of slab.

B = Breadth of span of slab.

(6) The amount of reinforcing steel may be gradually reduced to seventy-five per cent. of that calculated per foot in width, commencing at the quarter point and continuing to the support. The reinforcement spanning the shortest direction shall be placed below the reinforcement spanning the longer direction.

(To be continued).

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS.

Reinforced Concrete Buildings. By Ernest L. Ransome and Alexis Saurbrey. Published by the McGraw Hill Book Company, New York. Cloth, 6¼ × 9½ inches, 235 pages, 176 text figures. Price $2.50 net.

The authors of this volume are the president and chief engineer of the Ransome Engineering Company of New York. So many books on reinforced concrete of the stereotyped form have come to hand recently that it is a pleasure to note one on the subject of a different kind. The book covers the salient features of the design and construction of reinforced concrete buildings. The authors do not attempt to cover extraneous matter, but confirm themselves strictly to the subject in hand. The question of elementary structural theory and design is not taken up, but the authors treat the subject from the point of view of the experienced engineer. This is an advantage, for it allows of an expansion on features which make it most useful to the designer; on the other hand many books already exist which if necessary will furnish information with regard to earth pressures and the hundred and one other items included in the completed design. The book is divided into three parts, dealing respectively with the history of reinforced concrete, construction, the rational design of building and their practical construction. The history of reinforced concrete construction as narrated by Mr. Ransome is most interesting, and he is well qualified from his long connection with the methods used to deal with it. The part on design is a well arranged rational treatment of the subject. One serious criticism is to be noted, however, and that is that the authors have not seen fit to use the nomenclature now commonly used in connection with the theory of reinforced concrete.

The portion of the book devoted to practical construction is very good, taking up, as it does, materials of construction, floor systems, foundations, finishing operations, fireproofing, repairs, accidents, superintendents' specifications and the theory of beams as illustrated by texts. It must be said, however, that the personal part of both Mr. Ransome and Mr. Saurbrey obtrudes itself into the book far too much. Far too many references are made to Mr. Ransome's patents, work, etc., and Mr. Saurbrey's name might be left off many of the illustrations of finished work. The book forms a most valuable addition to the subject and should be in the library of every engineer interested in the design of reinforced concrete buildings.

Sewage Disposal. By George W. Fuller. Published by the McGraw-Hill Book Company, New York. Cloth, size 6 × 9 in., pp. 744, 80 illustrations. Price $6.00 net.

The announcement that a treatise on sewage disposal was being prepared by Mr. Fuller was made some time ago, and it was with more than ordinary interest that its appearance was awaited. Mr. Fuller's reputation in this field is too well known for any comment to be necessary as to his fitness for writing such a book. Now that the volume has been published we must say that the result is even beyond expectation. The book is an example of what a technical treatise should be. Among the numberless volumes now being presented to the engineering public it is refreshing to occasionally meet with one for which praise can be the only comment. The author with his intimate association of twenty-five years in the development of this branch of engineering science and his long experience in presenting clearly to his clients the purposes of the works he has designed, has eminently qualified him to write a book which is of equal service to the student of the subject and to the engineer of standing. Certainly, no one interested in the subject of sewage disposal should be without a copy. The author in the preface states the divisions into which the volume falls and while it is impossible in a short review to touch on all the features outlined, these divisions give a fair idea of the way in which the subject is taken up. The book is divided into four parts of approximately equal size. The first part is devoted to a very complete description of the composition of sewage, and the behavior of bacterial and biochemical processes in the decomposition of sewage. The importance of oxygen and deoxygenation not only as a means of measuring the strength of sewage but in the relation to proper conditions of the flow of sewage through collecting systems and various disposal devices, is discussed fully. The second part of the book is devoted to a recital of American experience in the disposal of sewage by dilution in inland streams, lakes, tidal estuaries and oceans. The limiting factors and conditions in present practice are described at length, with suitable summaries. The third part deals with the preparatory arrangements for the treatment of sewages. Descriptions are given of screening, settling tanks, septic tanks, chemical precipitation tanks, electrolytic treatment and strainers, with the present day practice with regard to each. The fourth part of the book deals with filtration matters with regard to present practice. The closing pages of the book are devoted to æration, sterilization and ozonization processes as they are now understood, with a few explanations as to institutional and residential plants, and a final comparative summary of general costs and efficiencies. The volume shows the results of an extraordinary amount of research not only in the technical press, but also in the gathering of data from existing plants. The treatise forms the most concise yet comprehensive text on the subject of sewage disposal which is in existence at the present time.

Suspension Bridges and Cantilevers.—Their Economic Proportions and Limiting Spans. By D. B. Steinman, C.E., Ph.D., Assistant Professor of Civil Engineering, University of Idaho. New York: D. Van Nostrand Co., Science Series. Boards, 4 × 6 inches. pp. 185, 1 plate. 50 cents.

Forty years ago Sir Benjamin Baker wrote an important monograph on "Long-Span Railway Bridges," in which he discussed and compared from the economic standpoint the types of bridges suitable for this class of construction. What was thus done for long-span bridge building in the materials then available has with equal effectiveness been done for present day conditions and materials by Professor Steinman in his readable little book just issued as one of the Van Nostrand Science Series.

The purpose of the writing is declared by the author to be the furnishing of adequate data from which the limiting and ecomonic spans for suspension bridges and cantilevers might be deduced in any consideration of the relative adaptability of the two types to long-span bridge construction. To this end designs and estimates of weight and cost were prepared for suspension bridges of 1,500, 2,250 and 3,000 feet span, and for cantilever bridges of 1,000, 1,500 and 2,000 feet span. The author then proceeds to establish the maximum practicable span for each type, the maximum economic span and the span of equal cost for the two types. It is of interest, but of doubtful practical value, to learn that the theoretical maximum span for suspension bridges and cantilevers, or the spans at which they cease to be self-supporting, is 14,700 feet for the former and 5,600 feet for the latter. The maximum practicable span for suspension bridges is established as varying from 3,500 to 4,900 feet, depending upon the live load, while for the cantilever the maximum practicable span is shown to be from 2,000 to 3,000 feet. These maximum practicable spans, it is explained are the limiting spans to which it would be possible to build the bridges in question, altogether apart from the character of the undertaking as an investment. Where bridges are required to pay their own way and not become a charge on those who erect them, the limiting span for the suspension bridge is set at 3,170 feet and for the cantilever 2,700 feet. The range of economic usefulness for the cantilever is defined as from 1,670 feet to 2,700 feet, and for the suspension bridge from 1,670 feet to 3,170 feet, the span of equal cost being 1,670 feet.

Several subsidiary investigations of value are included in the book such as the determination of the economic riseratio for suspension bridges, the minimum depth of stiffening trusses for adequate rigidity, the economic depth of stiffening truss, etc. Tables giving data concerning a large number of notable suspension and cantilever bridges and bibliographies relating to the subject add to the usefulness of the book.

While the conclusions relating to the maximum practicable spans are necessarily based upon debatable hypotheses, the author has made a contribution of distinct value to the engineering profession.—C.R.Y.

Centrifugal Pumping Machinery. By C. G. de Laval. Published by McGraw Hill Book Company, New York. Cloth, size 6¼ × 9½ inches, 181 pages, 19 tables, 159 illustrations. Price $3.

The book deals with the theory and practice of centrifugal and turbine pumps. There are few treatises in the English language which go into the principles which govern the actual design. The theories of centrifugal pumps are analyses based on certain assumptions, and but few of these analyses are at present published in English. The writer in this book gives three different theories which give approximately the same result. The basis of the principle of one of these is that the motion of the particles of water throughout the space between the blades strictly follows those particles contiguous to the blades. Another assumes that the water enters the inner periphery of the wheel in a radial direction across the entire width of the wheel. Neither of these assumptions is true, but they afford the means of attacking the problems which would otherwise be impossible. Many descriptions of existing installations are given. The book might be improved by the omission of some of the photographs, as they only occupy valuable room. The book will be a valuable one to both the designer of centrifugal pumps and the engineer who wishes some accurate knowledge on efficiencies, etc.

Dredges and Dredging. By Charles Prelini. Published by the D. Van Nostrand Co., New York. Cloth, size 6 × 9 inches, 280 pages, 82 illustrations. Price $3.

Dredging is a subject of considerable importance in our commercial life. Many millions of dollars are invested in plants and outfits, and as a result of dredging work vessels of great tonnage can now use the harbors of the world in safety. This treatise is a valuable addition to literature on the subject. The volume is a history of dredging showing the various stages up to the present time. The book is divided into twenty-nine chapters, devoted to different aspects of the subject and the various problems incidental to the work. Chapters are devoted to soils and their characteristics, excavation of sub-aqueous rock, hints on selecting dredges for various work, the different types of dredges in use, the cost of operating dredges, and much other valuable data. Complete descriptions of the methods used on recent large works are given. The book will be found to be a most complete and valuable exposition of the subject. The only criticism we would offer is the fact that wood cuts have been used in place of half-tones and zincs.

Tunnel Shields and the Use of Compressed Air in Sub-Aqueous Work. By William Charles Copperthwaite. Published by Constable and Co., Ltd., London. Second edition, revised. Cloth, size 8 × 11½ inches, with 260 illustrations and diagrams. Price $8.25.

There are very few accounts in English of shield work in tunneling operations. The employment of a shield, with of without the aid of compressed air, is of English origin, and the length of a tunnel so constructed in Great Britain is many times greater than the total amount of similar work elsewhere, yet the subject is no where dealt with with any degree of fulness in English text books. In this volume a history of recent developments in shield work is given and a collection of a mass of information scattered through many publications and consequently difficult and troublesome of access, is here made available. The work is a most authoritative one, and should form part of the library of every engineer interested in the use of compressed air in sub-aqueous work. The whole field of tunnel work with the use of compressed air is covered most thoroughly, and the volume includes descriptions of tunneling methods used to date on all the great works in Europe and America.

Valuation of Public Utility Properties. By Henry Floy. Published by McGraw-Hill Book Co., New York. Cloth, size 6¼ × 9½ inches, 386 pages. Price $5.

The valuation of utility property is of such recent date that at the present time there exists no general practice or formulated theory of the subject. No comprehensive text book exists, although much important information relating to valuation work has been published in various papers. This is the first attempt to digest and compile this material. The author states that he has endeavored to digest the opinions, papers, discussions, reports of commissions, and court decisions relating to the subject, in so far as possible, and to present the summary of the best practice with typical examples thereof. His aim has been to indicate, if possible, the line along which theory and practice seemed likely to be standardized. It must be said that he has succeeded very well in his object and has presented a well-balanced, logical discussion of the subject. Approved methods of ascertaining values are given, and the examples of appraisals used are more or less historic, and have already helped to establish precedence of current practice.

A Manual of Civil Engineering Practice. By F. Knowles Taylor. Published by Charles Griffin and Co., London. Cloth, size 6¼ × 9 inches, 809 pages, including index, with 1,179 illustrations, including 35 folding plates. Price, $7 net.

The author states that the work has been specially arranged for the use of municipal and county engineers. The discussion includes among many other subjects the mechanics of engineering, design of structures in brick, stone, reinforced concrete, roads, electric tramways, bridges, river works and land drainage, hydraulics and pumping machinery, waterworks and sources of supply, sewage disposal, sanitation, refuse disposal, and a chapter on specifications. With the limitations of space imposed on the author, he does not attempt to deal fully with many of the above subjects. A great deal of valuable information, however, is contained in the volume, and the book will appeal to the whole civil engineering profession as well as to the municipal engineer. One criticism must be registered against the work and this is, no doubt, due to the lack of space, that is, the brief mathematical treatment in connection with the development of some of the formulæ, which tend rather towards empiricism. The book should form a most valuable reference volume when the engineer lacks the time to look up the more highly specialized text book.

Reinforced Concrete Design Simplified. By John C. Gammon. Published by Crosby, Lockwood and Sons. Cloth, 9½ × 11 inches, 116 pages. Price $3.

The engineer has more and more to deal with the design of reinforced concrete in connection with building and engineering work Its many advantages as a system of construction have made its introduction one of the most important advances in engineering lines in the past century. It seems most probable that its use will increase with time. In the design of reinforced concrete, however, much valuable time must be used in making computations, which often have to be repeated many times with an accompanying waste of energy. The author has compiled a number of tables and diagrams which give at a glance the values of the different variables. These diagrams cover all phases of reinforced concrete design. For instance, having the bending moment for a beam, by reference to one of the diagrams, the economical size, the limiting conditions, the area of steel, the size of member required, can all be determined at a glance. Diagrams are also included for determining the sheer reinforcement, the design of columns, and of T beams. The book is extremely well indexed with side tabs for quickly turning to any required place, and the use of the diagrams is extremely simple. This book should be well received by the reinforced concrete designer. In fact, we would say that is is almost indispensable.

The Principles of Specification and Agreement Writing. By C. R. Young. Published by The Canadian Engineer, Toronto. Paper, 6 × 9 in., 47 pp. Price 25 cents net.

This book is made up of a series of six articles published in The Canadian Engineer on "Specification and Agreement Writing." The subject matter, the preliminaries to the contract, the composition of an engineering contract, the legal essentials and the desirable characteristics of an engineering contract, subject matter of the specification, specific and general clauses, the agreement and practical suggestions. The treatment is logical and clearly reasoned. The book is a most concise exposition of this most important subject and should be in the hands of every engineer engaged in preparing specifications.

Elements of Engineering Estimating. By A. Suggate. Published by The Technical Publishing Company, London. Cloth, size 5 × 7 inches, 135 pages. Price 90 cents.

This little volume, a practical handbook for students, draughtsmen and engineers, so the author states, gives in a suggestive manner the methods of estimating on engineering work. The prices given throughout the book are, of course, of use to Canadians on account of the difference in labor costs. The remarks and suggestions on the general basis of making estimates are very good however, and will repay attention by engineers on this side of the water.

Drill Work, Methods and Cost. Issued by the Cyclone Drill Company, Orrville, Ohio. Cloth, size 7 × 10, 350 pages.

A great many of the troubles encountered by drill-men are due to lack of experience or ignorance of the subject. While in no sense a catalogue, it contains valuable data pertaining to the drilling of wells and kindred subjects compiled by R. R. Sanderson, sales manager of the Cyclone Drill Company. Instructions are given as completely as possible, covering drilling operations, beginning with the setting up of the drill step by step through all the operations necessary to complete wells and blast holes in various kinds of material. The book is being distributed among the customers of the company and those interested in the subject.

A Short Course in Graphic Statics. By W. L. Cathcart and J. I. Chaffee. Published by the D. Van Nostrand Company, New York. Cloth, size 5 × 7½ inches, 180 pages, 58 illustrations. Price $1.50.

The aim of the book is to provide students of mechanical engineering with a brief course in graphic statics. The treatment has been restricted to the properties and general uses of the force and equilibrium polygons, as the author assumes that this is sufficient for the solution of most of the problems met in practice by a mechanical engineer. Some little attention has been given to the stresses in girders, etc.

Practical Gyrostatic Balancing. By Herbert Chatley. Published by The Technical Publishing Co., Ltd., London. Cloth, size 5 × 7½ inches, 72 pages. Price 65c.

This book forms a small and inexpensive treatise on the subject of gyrostatic control. This piece of apparatus is becoming daily of more and more importance in connection with the question of the automatic balancing of all kinds of locomotives, vessels and air-craft. The book should prove useful to inventors and engineers who desire a working knowledge of its mechanism.

Treatise on Hydraulics. By Mansfield Merriman. Ninth edition. Published by John Wiley and Sons, New York. Canadian agents, Renouf and Co., Montreal. Cloth, 6¼ × 9½ in., pp. 565, 224 figures. $4 net.

Merriman's hydraulics, which in this volume has reached the ninth edition and thirty-seventh thousand, needs little comment other than to note the changes rendered necessary by the advances in the subject. The book is known by all engineers and has become a standard textbook on the subject. The book in this edition has been revised and reset in order to cover the advances of the last nine years since the eighth edition was issued. The new matter includes descriptions of hydraulic instruments, methods of measuring water, oblique weirs, submerged tubes, regulating devices for pipes, conduits, dams, backwater, rainfall, evaporation

and runoff. The tables of coefficients for orifices, weirs, pipes, conduits, and channels have been revised and extended so as to include the results of recent experiments. A change in the old arrangement of the tables is noted; instead of being collected at the end of the book they are now placed in the text in connection with the matter explaining them.

PUBLICATIONS RECEIVED.

American Railway Bridge and Building Association. Proceedings of the 21st Annual Convention, held at St. Louis, Mo., October 17-19, 1911. Published by the Association. C. A. Lichty, secretary, 226 W. Jackson Boulevard, Chicago, Ill.

Department of Public Works. The annual report of the Department of Public Works of the Province of Saskatchewan for the year 1911.

Progress of Steam Measurements. Report for the calendar year 1910, by P. M. Souder, C.E., Department of the Interior, Dominion of Canada.

Ottawa River Storage and Geodetic Levelling. Reports on the above, being Vol. 2 of the report of the Minister of Public Works, Dominion of Canada.

U. S. Government Specifications for Portland Cement. Circular of the Bureau of Standards No. 33. S. W. Stratton, director. Issued May 1st, 1912, by the Dept. of Commerce and Labor, U.S.

Report of Board of Commissioners, Toronto Waterworks, 1912. Report upon the existing waterworks system and upon an additional water supply for the city of Toronto, by the Consulting Board recently appointed.

Report of the Department of Mines, 1911. For the Province of Nova Scotia. Copies may be obtained from the Commissioner of Public Works and Mines, Halifax.

Sanitary District of Chicago. Being the papers relating to the application of the Sanitary District of Chicago for permission to divert 10,000 cubic feet of water per second from Lake Michigan. Issued by the Department of Marine and Fisheries, Canada.

An Investigation of the Coals of Canada with Reference to their Economic Qualities. In six volumes, by J. B. Porter and R. J. Durley, assisted by P. C. Dennis, E. Stansfield and a staff of special assistants. Vol. 1 issued by the Mines Branch, Department of Mines, Canada. Price $1.

Report on the Geology of the Area Along the T. and N. O. Railway (Ontario Government Railway). Trial line between Gowganda and Porcupine, by J. G. McMillan.

The Strength of Reinforced Concrete Beams. Being the results of tests of 333 beams. By Richard L. Humphrey and Louis H. Losse. No. 2 Technological Papers of the Bureau of Standards, Dept. of Commerce and Labor, U.S.

The Los Augeles Aqueduct. Sixth annual report of the Bureau of the Los Angeles Aqueduct. Wm. Mullholland, chief engineer, Los Angeles, 1911.

American Wood Preservers' Association. Report of the proceedings of the eighth annual meeting held at Chicago, Ill., Jan. 16-18, 1912. F. J. Angier, secretary-treasurer, Baltimore, Md.

U.S. Reclammation Service. The tenth annual report, 1910-1911. F. H. Newell, director, Department of the Interior, U.S.

Water Power Development in the United States. Report of the Commissioner of Corporations. Issued March 14th, 1912. Dept. of Commerce and Labor, Washington.

Year Book, 1911, Swedish Chamber of Commerce in London. Containing the fifth annual general report of the Council, London, E.C.

Waterworks Efficiency. Bulletin of the Milwaukee Bureau of Economy and Efficiency. On the present capacity and future requirements. By F. E. Turneaure, Milwaukee, Wis.

Massachusetts Institute of Technology. Contributions from the Sanitary Research Laboratory and the Sewage Experiment Station. Vol. 8, issued by the Dept. of Biology and Public Health, Massachusetts Institute of Technology, Boston. Price $1.

The Present State of Development of Large Steam Turbines. By A. G. Christie. Being a re-print from the journal of the American Society of Mechanical Engineers.

Practical Road Engineering. For the New Traffic Requirements. Compiled from the special "Roads" issues of the "Surveyor" and "Municipal and County Engineer," by H. Percy Boulnois. The St. Bride's Press, Ltd., London.

Mechanical Engineer's Price Book, 1912. Edited by Geoffrey Brooks. Issued by E. and F. N. Spon, Ltd., London.

A Model Erection Shop is the title of a very artistic 16-page booklet just issued by Lockwood, Greene and Co., architects and engineers for industrial plants, 93 Federal St., Boston. It describes with illustrations the construction of a one-storey, reinforced concrete, sawtooth roofed machine shop which is unusually well lighted, and at the same time has its floor area covered by an abundance of cranes running on concrete girders. The booklet will be sent on request to Lockwood, Greene and Co., 93 Federal St., Boston.

CATALOGUES RECEIVED.

The Morrison Water Tube Boiler. Circular No. 1, describing boiler recently patented in the United States and Canada. Copies of pamphlets may be obtained from Egbert R. Morrison, general sales agent, Sharon, Pa.

Concrete Mixers. Circular issued by The Cement Tile Machinery Co., Waterloo, Iowa, describing their small batch concrete mixers.

Machinery and Supplies. Catalogue No. 42, illustrating machinery and supplies for the mining man. Mussens, Limited, Montreal.

Road Machinery. Pamphlet issued by The Barron and Cole Company, Barron Bldg., New York City, illustrating different types of road machinery manufactured by them.

Electrical Wires and Cables. Catalogue and hand-book bound in red morocco, illustrating electrical wires and cables manufactured by The Canada Wire and Cable Company, Limited, Toronto, Canada.

Sewage Appliances. Book issued by Tuke and Bell, Limited, sewage specialists, London, E.C., illustrating different types of sewage sprinklers, distributors, sewage installation, air compressors, flushing syphons, etc.

Rock Drills. Pamphlet issued by McKierman-Terry Drill Co., 115 Broadway, New York, illustrating their "Wizard" rock drills.

Manganese Steel. The Taylor Iron and Steel Co., Highbridge, N.J., forward pamphlet describing their "Tisco" manganese steel crusher, hammers, screen plates, etc.

Steam Pumps. Catalogue No. 8 of the Smart-Turner Machine Co., Ltd., Hamilton, illustrating different types of pumps manufactured by them.

Continuous Reinforced Concrete Pipe. The Lock-Joint Pipe Co., 165 Broadway, New York, forward their latest catalogue on concrete pipe constructed under the Meriweather system. A very artistic catalogue showing a number of recent installations of the pipe.

Waterworks Specialty. The Waterworks Equipment Co., 50 Church St., New York, present catalogue illustrating special types of hydraulic apparatus. Copies may be obtained by addressing the company.

Alternating Current Generators. Pamphlet No. 13b, issued by Pruce Peebles and Co., Ltd., of Edinburgh, illustrating Peebles medium and slow speed alternators.

Machine Tools for Heavy Work. The Wiener Machinery Company, 50 Church St., New York, representatives for the United States and Canada of Ernst Schiess, of Dusseldorf, Germany, forward catalogue illustrating different types of heavy machine tools, turning lays, boring mills, planing and milling machines, etc.

Steel Forms and Centering. The Standardized Steel Form Company, Niagara Falls, Ont., forward pamphlet illustrating the Blayney Collapsible and telescoping system of steel forms and centering for plain or reinforced, seamless, concrete pipe. Copies may be obtained by addressing the Standardized Steel Form Company, Niagara Falls, Ont.

Hydraulic Benders is the title of a new and interesting 64 page 6 in. by 9 in. catalogue devoted exclusively to hydraulic machines just published by The Watson-Stillman Co., 50 Church St., New York. Free copy will be mailed to interested parties requesting Catalogue No. 83.

CLAYS AND CLAY INDUSTRIES OF EDMONTON DISTRICT.

The Edmonton Board of Trade some months ago requested Professor Orton, an authority on clay and clay industries, to make a report on the possibilities in that direction in the Edmonton district. Professor Orton was asked to report upon the following points:—

1. Are the clay industries now established at or near Edmonton producing from their available material as good products as is practicable from the material they are using?

2. Are there other clay materials in the neighborhood available for the production of different and more valuable products than are now being made, and if so, what are the possibilities?

In answering the first question, Professor Orton states that two distinct classes of material are now being used here, consisting of (a) the glacial clays of the upper levels, and (b) the deposits on the river flats, composed of the silt deposited by the river in eddies and quiet spots and left by receding floods.

In regard to the material under class (a), the report seems to indicate that these materials present certain difficulties not commonly met with in other districts where the industries have attained considerable development. The report states that "the strata being worked showed the typical faults of glacial clay beds, viz., lack of continuity in character. They were shifting and changing in proportions of sand from day to day, and the problem of the pit foreman, to keep a reasonably fixed proportion of both clay and sand going up in each car load, is not an easy one, and will require constant vigilance. The quality of the body produced by this mixture of tough and sandy material, as evidenced by the kilns of brick standing burnt and ready for shipment, as well as by the waste piles and bats lying about, is fairly good for common building brick. It is not in any sense a fine material, but it makes a fairly good, strong and serviceable common brick. There seems no likelihood of making any materially different or materially improved product from this clay."

The report indicates that the material in class (b), that is to say, the river silt deposited on the river flats, presents even greater difficulties. The report states that these clays are alike in one respect, namely, they are all very treacherous and difficult to dry without cracking. The upper brown layer, worked alone, would make a fairly tough, plastic paste, and would work well in the machinery, but it would give prohibitive trouble in drying. The use of the sandy and silty layers is absolutely imperative to weaken it, to get sound or unchecked bricks. On the other hand, the sand and silt is of itself too weak and friable to make a brick, and is equally fatal to the quality of the burnt product, if allowed to get too high in amount. The manufacturers are, therefore, between two horns of a dilemma—cracking on the one hand, and weak, crumbly, worthless product on the other.

To quote the report: "If by constant vigilance the proportions can be kept inside the proper limits, the product will be a somewhat pale red brick of rather low, but sufficient strength, which, when in position in a building, will doubtless give good service.

"The possibility of improving the brick as to its hardness, strength and color by use of other processes than those employed has been considered. I cannot hold out any hopes of any important improvement in these respects."

In regard to the second point on which Professor Orton was asked to report, the results of his investigations indicate that there are possibilities of very important development. These occur in connection with the stratified shale and clay of an earlier formation than the glacial deposits or river silt now being used.

An exhaustive series of tests was made on samples of shales and fire clays taken from the various mines in the vicinity and from points along the river bank where the original stratified shales were exposed. While these materials present difficulties which do not occur in the clay deposits of Ohio, Pennsylvania, and other portions of the continent where clay industries have reached large proportions, it appears to be the opinion of Professor Orton that these difficulties are not insuperable, and that the profitable production of other and more valuable products, such as certain forms of tile and terra cotta and vitrified products, is commercially possible.

The project is rendered difficult by the somewhat abnormal character of these clays and shales. They show peculiarly sticky and soapy characteristics, which render them hard to work in the moulds; and they also show an abnormal percentage of shrinkage in drying, resulting in an amount of cracking, rendering the products useless. By an exhaustive series of experiments Professor Orton has demonstrated that treatment can be devised which will overcome these difficulties. While such treatment will materially increase the expense of manufacture, the cost is not considered by any means prohibitive, in view of the cost now entailed in bringing such products from present sources of supply. It is not practicable to enter into details of the elaborate experiments conducted by Professor Orton along these lines, and parties interested are advised to study the full report in the secretary's hands.

Professor Orton concludes his report as follows: "To utilize the Edmonton shales and fire clays is a proposition that should not be undertaken by any person or corporation who have not considerable financial resources, and who have the courage to use them. It is highly likely that a considerable period of expensive and costly experimenting would have to be made before a plant could be adjusted to do on a large scale what has been demonstrated on a small scale in the foregoing tests. On the other hand, a firm that has the money and intelligence to take up and solve this problem along the lines here laid down will, in my opinion, be able to produce vitrified clay products of at least fair quality at a cost far below that at which the goods can be brought in either from Vancouver or Ontario, or the nearest American clay-working centres."

ENGINEERING NOTES.

Galt, Ont.—Mr. W. H. Breithaupt, C.E., of Berlin, Ont., explained his proposed system of storage dams, to prevent disaster from excessive water in the Grand River, before a largely attended meeting of the board of trade. In a clear manner the speaker explained the reasons for flood conditions and the feasibility of a scheme for holding back a large portion of the water, thus reducing the danger of damage to property and providing a reservoir from which the water could be supplied in the summer months to maint in a reasonably good flow and provide continuous water power.

Montreal, P.Q.—Civic Controller Ainey has proposed a new scheme for the elimination of the level crossings of the Grand Trunk Railway within the limits of this city.

Mr. Ainey proposes to build tunnels under thirteen of the streets where these crossings are situated, devoting the two million dollars, which the city is being asked to contribute toward the cost of elevating the tracks, for this purpose.

He claims his scheme will save $1,000,000 in the expenditure for this work.

PERSONALS.

MR. CHAS. MOOGK has received the appointment of city engineer for the municipality of Waterloo, Ont.

MR. JOHN O'NEILL has been appointed to the position of municipal engineer for the city of Fredericton, New Brunswick.

MR. ANDREW BASHFORTH has been appointed general manager of the Provincial Steel Company, Limited, Cobourg, Ont.

MR. R. H. LEE, engineer for the municipality of Kamloops, British Columbia, has tendered his resignation to the civic authorities.

MR. GREGORY FEENEY has been appointed to a position on the engineering staff of the St. John & Quebec Railway Company.

MR. JAMES RUDDICK has been appointed to the position of general construction engineer for the Dominion Coal Company at Glace Bay, Nova Scotia.

CHIEF ENGINEER BRUCE, of the Dominion Government service on the final location of the second section of the Hudson Bay Railway, has resigned his position.

MR. JOHN L. FEENEY has retired from the office of engineer for the municipality of Fredericton, N.B., and will take a position in the Dominion Engineering Department in the city of St. John, N.B.

MR. FRANK E. STERNS will be on the engineering staff of the new Welland Canal, and will devote his energies to the matter of lock design. He is a Canadian and a graduate of McGill University.

MR. MORRIS F. G. WILSON, an English authority on drydock construction, arrived in Ottawa May 24th, and will act for the government in the selection of a suitable site for the proposed Quebec drydock.

MR. GROVER KEITH, formerly of Sussex, who has been on the staff at the St. John & Quebec Railway Company's offices, has been appointed to a residency on the line between Fredericton and Gagetown, N.B.

MR. R. C. HARRIS has been appointed to the position of works commissioner for the city of oronto. In addition to the duties accompanying this office he will be supervisor of the cleaning of streets and the disposal of garbage.

MR. E. W. RICHARDS, head of the stores and purchasing department of the Toronto hydro-electric department, has been appointed to the position of appraiser in the customs department of the Dominion Government.

MR. WALTER H. FLYNN has been appointed to the position of superintendent of motive power on the lines of the Michigan Central Railway. Mr. Flynn, previous to this appointment, was master mechanic of the same company.

MR. R. G. SNEATH, C.E., a graduate of Toronto University, has been appointed to the position of resident engineer on the installation of the sewage disposal plant for the municipality of Melfort, Saskatchewan, for Messrs. McArthur and Murphy.

JACOBS & DAVIES, Inc., have opened their Montreal office in the Eastern Townships Bank Building, 263 St. James Street, for the practice of general consulting and construction engineering, which business will be under the management of Mr. Paul Seurot, their representative in Canada.

MR. W. S. HARVEY, A.M., Inst. C.E., chief assistant engineer for the city of Lethbridge, Alta., has just been elected an associate member of the Canadian Society of Civil Engineers. Prior to coming to Canada in 1910 Mr. Harvey was in charge of the sewerage and general engineering work for the city of Plymouth, England.

MR. J. J. TAYLOR, who has lately been engaged on the Gibson and Minto line, has been appointed inspecting engineer for the Federal Government on the St. John Valley Railway, and will enter upon his new duties at an early date. Mr. Taylor was in charge of part of the preliminary survey work on the Valley Railway for the Provincial Government some time ago.

Mr. J. B. CHALIES, B.A.Sc., graduate of the University of Toronto, has been appointed superintendent of the new water-power branch of the Department of the Interior, which was originally under the Railway and Swamp Lands branch of the Department. The new water-power branch will make surveys of all the water-powers of Canada and gather data on stream fall.

CAPTAIN L. A. DEMERS has been appointed to the position of harbor master of the port of Montreal. Captain Demers is a native of Montreal, having been born in that city August 18th, 1862. He was educated in St. Mary's Academy and holds a commercial certificate from that institution. In 1878 he became an apprentice on a sailing vessel, and in 1886 was made mate; his final examination as master was passed in 1889. For some time he has been Dominion wreck commissioner.

MEETINGS.

Montreal, P.Q.—The Montreal Electrical Society, which has arranged a somewhat ambitious programme for the coming summer season, held a most important meeting Tuesday evening last at the Fraser Institute Hall. The primary object of this new society appeals to the younger members of the electrical industry, as it fills a want long felt, with the opportunity for local electrical men, young and old, to meet, exchange views, and take advantage of professional papers to be read by some of Canada's leading electrical engineers. With a membership approaching the two hundred mark, this new society appears to have made a good start. As the society will pay several visits to neighboring power plants, accompanied by classified engineers, the benefit to the younger members is easily seen.

MEETING OF AMERICAN SOCIETY OF ENGINEER DRAFTSMEN.

The regular monthly meeting of the American Society of Engineer Draftsmen, held on May 16th, in the Engineering Societies' Building, was marked by the admission to junior membership of Miss Marie Oberlander, a student of architectural drawing at Teachers College, Columbia University. Miss Oberlander is the first woman to be elected as a member of this organization.

The guest of the evening was Mr. F. F. Nickel. M.E., consulting engineer to the Worthington Pump Co., who delivered a very interesting and instructive lecture on "Practical Application of the Slide Rule."

A paper by Mr. R. E. Boehck, a member of the society, of Evansville, Ind., on "The Development of Logging Machinery," was read and discussed.

COMING MEETINGS.

FOURTH NATIONAL CONFERENCE ON CITY PLANNING.—May 27th-29th. Meeting, Public Library, Boston, Mass. Sec'y, Flavel Shurtleff, 19 Congress Street, Boston, Mass.

AMERICAN WATER WORKS ASSOCIATION.—June 3rd 8th. Annual Convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N.Y.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithica, N.Y.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary. Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President, J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

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CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
5-29—Water works, sewerage and electric light systems, Melfort, Sask.	(P. & S.)	5-2
6-10—Electrical equipment, Vernon, B.C.	(S.)	5-16
6-17—Electric Generating Station Equipment, Bassano, Alta.	(S.)	5-30
6-10—Cement sidewalks, Maple Creek, Sask.	(P & S.)	5-30

(Melfort plans and specifications are also on file at The Canadian Engineer Offices, 820 Union Bank Building, Winnipeg, and B33, Board of Trade Building, Montreal).

(Vernon specifications are on file at The Canadian Engineer Offices, Winnipeg and Montreal; Mather, Yuill & Company, Limited, Consulting Engineers, Vancouver, B.C.)

(Bassano specifications also on file at the office of The Canadian Engineer, Montreal)

(Maple Creek plans and specifications on file at The Canadian Engineer Office, Winnipeg, Man.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Australia, steel rails and fish plates	May 29.	May 2.	60
Bassano, Alta., electric generating machinery	June 3.	May 16.	66
Berlin, Ont., waterworks improvements		May 23.	72
Edmonton, Alta., pile wharf	June 17.	May 23.	60
Fredericton, N.B., wharf	June 6.	May 16.	60
Hamilton, Ont., castings, meters, etc.	May 30.	May 2.	72
Hamilton, Ont., motors, turbine pumps, etc.	June 3.	May 16.	74
Kenora, Ont., fire hall	May 31.	May 23.	59
Lebret, Sask., school house	May 31.	Apr. 25.	61
Lunenburg, N.S., sewerage system	June 1.	May 9.	60
Melfort, Sask., waterworks, sewerage, etc.	May 29.	May 2.	72
Melfort, Sask., school building	May 29.	May 16.	60
Moose Jaw, Sask., water works fittings	May 30.	May 16.	74
Moose Jaw, Sask., retaining wall and sidewalks, Collegiate Institute	June 5.	May 16.	60
Moose Jaw, Sask., valves and hydrants	June 1.	May 23.	72
Moose Jaw, Sask., sewer pipe and specials	June 1.	May 23.	72
Moose Jaw, Sask., cast-iron pipe and specials	June 1.	May 23.	74
Montreal, Que., bridge Bevan's Creek	June 1.	May 23.	59
Ottawa, Ont., coaling stations	May 31.	May 9.	72
Ottawa, Ont., mail contract	June 21.	May 23.	76
Ottawa, Ont., station and other buildings	May 31.	May 9.	74
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., fishing protection vessel	June 17.	Apr. 18.	74
Ottawa, Ont., design and construction of steamship	June 30.	May 16.	76
Owen Sound, Ont., wharf	June 4.	May 16.	60
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Quebec, Que., leasing of water-powers	June 26.	May 2.	72
Saskatoon, Sask., garbage incinerator	June 25.	May 2.	74
Sault Ste. Marie, Ont., approach to wharf	June 4.	May 16.	60
Toronto, Ont., cast-iron penstocks	June 4.	May 9.	74
Toronto, Ont., storm overflow sewer	June 4.	May 16.	72
Toronto, Ont., dredging	June 4.	May 23.	72
Toronto, Ont., bridge construction	June 6.	May 23.	72
Toronto, Ont., concrete abutments	June 5.	May 23.	72
Toronto, Ont., concrete breakwater	June 6.	May 23.	72
Vancouver, B.C., bridging, grading, etc.	May 31.	May 9.	62
Vernon, B.C., electrical equipment	June 10.	May 16.	72
Vernon, B.C., cast-iron pipe	June 10.	May 23.	60
Vernon, B.C., valves and hydrants	June 10.	May 23.	60
Winnipeg, Man., Court House	June 1.	May 23.	60

TENDERS.

Amherst, N.S.—Tenders will be received up to Monday, June 3rd, 1912, for the following work:—Digging trench, depth ordered by Engineer, laying and caulking cast-iron water pipe, and backfilling trench, on six streets in the town of Amherst, N.S. Specifications and all other information may be obtained at the office of W. F. Donkin, Town Clerk, Amherst, N.S.

Bassano, Alta.—The time for receiving tenders for electric generating station equipment has been extended until June 17th. Specifications at the offices of The Canadian Engineer, Toronto and Montreal. (See advt. in The Canadian Engineer).

Calgary, Alta.—Tenders will be received until June 3rd, 1912, for the erection and completion of combined police and fire stations for the city of Calgary. Plans, specifications and full particulars at the office of the architects, Messrs. Lang and Major, Suite 11, Board of Trade Building. J. M. Miller, city clerk, Calgary.

Edmonton, Alta.—Tenders will be received up to noon of June 10th, 1912, for the ornamental iron and stair work required in connection with the new court house at Calgary. Specifications, plans, etc., may be had at the Structural Engineer's office, new Parliament Buildings, Edmonton, or at the branch office of the Department of Public Works, Calgary. John Stocks, Deputy-Minister of Public Works, Edmonton, Alta.

Lethbridge, Alta.—Tenders for paving a number of lanes in concrete will be received up to noon of Friday, June 14th, 1912, by G. W. Robinson, secretary-treasurer. Plans and specifications may be obtained at the office of A. C. D. Blanchard, City Engineer, Lethbridge.

Maple Creek, Sask.—Tenders will be received up to June 10th, 1912, for the supplying of material and construction of approximately 7,000 yards of cement sidewalks in the town of Maple Creek. Plans and specifications can be seen at The Canadian Engineer office, 820 Union Bank Building, Winnipeg, and at the office of the secretary-treasurer, D. Paterson. (See advt. in The Canadian Engineer).

Moose Jaw, Sask.—Tenders for the supply and delivery of 50 ornamental light standards suitable for Tungsten lighting, will be received up to noon of June 14th, 1912, by the City Commissioners. Plans, etc., may be obtained from J. D. Peters, electrical superintendent, Moose Jaw.

Newmarket, Ont.—Tenders will be received by O. E. Tench, architect, up to the evening of June 15th, 1912, for the erection of a six-roomed Public school building in the town of Newmarket. Building to be of stone and brick, with artificial stone trimmings; flat roof; plumbing; warm air heating. Plans and specifications may be seen at the office of architect. Dr. C. H. R. Clark, Chairman of Board, Newmarket.

Oshawa, Ont.—Tenders will be received by the Town Engineer up to noon of June 8th, 1912, for the construction of 25,000 sq. ft., more or less, of cement concrete sidewalks. (See advt. in The Canadian Engineer). Frank Chappell, C.E., Town Engineer.

Ottawa, Ont.—The time for receiving the tenders for the construction of station and other buildings on the Transcontinental Railway is extended to noon of June 14, 1912. P. E. Ryan, secretary, the Commissioners of the Transcontinental; Railway, Ottawa. (See advt. in Canadian Engineer.)

Ottawa, Ont.—Tenders will be received by the Public Works Department, Ottawa, until June 4th, 1912, for dredging at Miramichi Bay, N.B. Combined specifications and form of tender can be obtained on application to the Secretary of the Department.

Ottawa, Ont.—The Department of Public Works will receive tenders until June 4th, 1912, for electric light wiring, fittings, etc., for the Post Office building, Port Hope, Ont. Plans and specifications to be seen on application to the caretaker of the building, Mr. Jas. Curtis, or to Mr. Thos. Hastings, Clerk of Works, Postal Station "F," Yonge Street, Toronto, and at the Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the construction of a rifle range at Chatham, Ont., will be received by the Director of Contracts, Militia Headquarters, Ottawa, until noon of May 30th, 1912. Plans, etc., can be seen at the offices of the officer commanding the first division, London, Ont.; at the office of Lt.-Colonel J. S. Black, brigade major, 1st Infantry Brigade, Chatham, Ont.; and at the office of the director of engineer services, headquarters, Ottawa. Eugene Fiset, colonel, deputy minister, Dept. of Militia and Defence, Ottawa.

Ottawa, Ont.—Tenders will be received until July 2nd, 1912, for the erection of a number of buildings for Indians on Reserves No. 2, 3 and 4, Fort George, B.C. J. D. McLean, Asst. Deputy and Secretary, Department of Indian Affairs, Ottawa.

Saskatoon, Sask.—Tenders will be received up to noon of June 5th, 1912, for all trades required in the erection and completion of an hotel on Twentieth Street, Saskatoon, for R. J. Barry, Esq. Plans and specifications can be seen at the Builders' Exchange, Saskatoon; and at the offices of the architects, Thompson, Daniel & Colthurst, Central Chambers, Saskatoon.

St. Catharines, Ont.—Bulk or separate tenders will be received for the erection and completion of a Sunday School building for St. George's Church, St. Catharines, Ont., until June 10th, 1912. A. E. Nicholson, O.A.A., architect, 46 Queen Street, St. Catharines, Ont.

Tisdale, Sask.—Tenders for the various works and materials in connection with installing a system of storm water sewers in the village of Tisdale, will be received up to June 15th, 1912. Plans and specifications may be seen at the office of the Commissioner of Public Health, Regina; or at the office of the Secretary-Treasurer, W. E. Moore, Tisdale.

Toronto, Ont.—Tenders for the supply and delivery of coal and wood required for Government House, Parliament Buildings, Osgoode Hall, Normal and Model Schools, Toronto, and for the Normal Schools at Ottawa, London, Peterboro, Hamilton, Stratford, North Bay, the Institutions for the Deaf and Dumb, Belleville, and the Institution for the Blind, Brantford, for 12 months ending 30th June, 1913, will be received up to noon of June 4th, 1912. Forms of tender, etc., at the office of H. F. McNaughten, Secretary Department of Public Works, Toronto, Ontario.

Toronto, Ont.—Tenders for dredging Murray Canal will be received at the office of L. K. Jones, Secretary Department of Railways and Canals, Ottawa, until June 5th, 1912. Specifications, etc., can be seen at the office of the Chief Engineer of the Department of Railways and Canals, Ottawa, and at the office of the resident engineer of the Ontario-St. Lawrence Canals, Cornwall.

Toronto, Ont.—Tenders for regulators will be received by the Secretary, Toronto Electric Commissioners, City Hall, Toronto, until noon of Wednesday, May 29th, 1912. Specifications may be seen and forms of tender obtained from the Toronto Hydro-Electric System, 31 William Street, Toronto. P. W. Ellis, chairman.

Toronto, Ont.—Tenders, whole or separate, will be received by the Secretary-Treasurer of the Board, until Friday noon, May 31st, 1912, for the several trades required in the erection of a new school building on Manning Avenue, enlargement of Pape Avenue School, and for heating and ventilation, plumbing and electrical work in the new Duke of Connaught School on Morley Avenue, also for sale of old buildings. Full particulars may be obtained at the offices of the Superintendent of Buildings, City Hall. W. W. Hodgson, chairman of committee; W. C. Wilkinson, secretary-treasurer.

Toronto, Ont.—Tenders for the construction of a concrete arch bridge over Copeland's Creek, between Concessions 13 and 14, Township of Tiny, County of Simcoe, and known as McConnell's Bridge; and also for a combined concrete slab bridge, dam and abutments at Lot 12, Concession 4, known as Gregg's Bridge, will be received until Saturday, June 8th, 1912. Plans and specifications at the office of Frank Barber, Esq., Civil Engineer, 57 Adelaide Street East, Toronto. (See advt. in The Canadian Engineer).

Toronto, Ont.—Tenders will be received by the Chairman of the Board of Control, City Hall, Toronto, up to noon of June 5th, 1912, for the construction of cribs for Princess Street Yard, also additions to retaining walls of the Weston Road viaduct. Specifications, etc., at the Department of Railways and Bridges, City Engineer's office, Toronto. G. R. Geary, (Mayor), Chairman, Board of Control. (See advt. in The Canadian Engineer).

Toronto, Ont.—Tenders will be received by the Chairman, Board of Control, City Hall, Toronto, up to noon of June 4th, for the construction of asphalt, bitulithic and concrete pavements, grading, concrete curbs, concrete walks, sewers, and steel pipe for a number of streets in the city of Toronto. Specifications and full particulars may be obtained at the office of the City Engineer, Toronto. G. R. Geary, (Mayor), Chairman, Board of Control.

Toronto, Ont.—Tenders will be received at the office of Frank Barber, Esq., Civil Engineer, 57 Adelaide Street East, Toronto, up to noon of June 8th, 1912, for the construction of a concrete abutment for a bridge, known as the Clubine Bridge on Yonge Street, in the County of York, about 1½ miles north of the town of Aurora. Plans, etc., at the office of the engineer. (See advt. in The Canadian Engineer).

Toronto, Ont.—Tenders for all trades in connection with midsummer repairs to the Separate schools for the S[illegible] School Board for the city of Toronto, will be received till 5 p.m., June 3rd, at the office of the Board, 24 Duke Street. Specifications, etc., at the office of the architect, Chas. J. Read, 404 Confederation Life Building, Toronto.

Vancouver, B.C.—Tenders will be received by Messrs. Mackenzie, Mann and Company, Ltd., Metropolitan Building, Vancouver, B.C., up till noon of July 8th, 1912, for the superstructures and substructures of ten bridges over the Fraser, Thompson, and North Thompson Rivers on that section of the Canadian Northern Pacific Railway between Port Mann and the Yellowhead Pass, Province of British Columbia. Detailed drawings, specifications, etc., may be obtained on or after June 5th, 1912, at the office of the Consulting Engineers, Waddell & Harrington, Winch Bldg., Vancouver, B.C. (See advt. in The Canadian Engineer).

Tarvia

Preserves Roads
Prevents Dust~

Mount Pleasant Cemetery, Toronto. Roads built with Tarvia X in 1909.

Two Years' Trial in Toronto

THE above roadway in Mount Pleasant Cemetery, Toronto, was built with "Tarvia X" in 1909. The photograph was taken in the fall of 1911 and gives a fair idea of the excellent condition of this road, after two years of travel.

In the background this road has a five per cent. grade and if ordinary macadam had been used the surface would be raveled and worn out long ago. The best demonstration of the success of Tarvia is that the Cemetery authorities, after two years, are going to use a great deal more of it, as the following letter from the Superintendent shows:

February 15th, 1912.

Dear Sirs:

I wish to let you know we will require "Tarvia X" to build about 6500 yds. of road this year about the end of July.

I may say that we are well pleased with our Tarvia roads. The first that were made in 1909 have stood the test of traffic and heavy loads up to 16 tons—the wagon wheels leaving no impression.

Where our roads have a 7% grade we find the Tarvia fills the bill; no washing, no dust, easy to sweep and clean in wet weather.

(Signed) W. H. FOORD, Supt.

Tarvia is a dense, viscid tar product of great adhesive power. When built into the road as a binder, it forms a matrix about the stone, keeps the stone in position and furnishes an element of plasticity which greatly prolongs the life of the macadam under heavy loads or automobile traffic. There are three grades for different types and conditions of roads.

Booklets regarding same free on request.

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MONTREAL TORONTO WINNIPEG VANCOUVER

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ST. JOHN, N.B. HALIFAX, N.S.

CONTRACTS AWARDED.

Cobourg, Ont.—Messrs. McLaren and Co., 65 Cumberland Street, Toronto, have been awarded the contract to erect a sewage disposal works for the House of Refuge in this municipality.

Lethbridge, Alta.—Messrs. Smith Bros. and Wilson were the successful bidders on the tender to erect a manual training school. The building is to cost $35,150, not including the plumbing work. Other bidders were W. H. Holt at $35,750, and Hotson and Leader at $59,200.

London, Ont.—At a meeting of the Commissioners the Gartshore-Thomson Company, of Hamilton, was awarded the contract for supplying all the pipe at $35 a ton for special orders, and $31 a ton for pipe from 4 inches to 18 inches in diameter. Jenkins Bros., of Montreal, were given the contract for valves from 4 to 12 inches, the prices varying from $5.42 for the smallest to $35.63 for the largest. The tender of the London Foundry Company for the 18-inch valves at $150 was accepted.

Moose Jaw, Sask.—Messrs. Fielding and Shepley, St. Paul, Minn., U.S.A., have been awarded the contract for approximately 34,000 square yards of paving, their prices being:—

Fielding and Shepley, St. Paul.—3", 16 lb. treatment creosoted wood paving blocks, paving per square yard, $2.84; between tracks extra per square, 30c.; excavation per cubic yard, 65c. (Accepted.)

Alternative tender.—3½ blocks, paving, $3.10; between tracks, 30c.; excavation per cubic yard, 65c.

Other tenders received were as follows:—

Bitulithic and Contracting, Limited, Winnipeg.—Bitulithic paving 5" in thickness, paving (lanes excluded) per square yard, $2.90; between tracks per square yard, extra, 30c.; excavation per cubic yard, 70c.

R. Bangham, Windsor, Ont.—2½ asphalt block, paving per square yard, $3.44; between tracks per square yard, extra, 6c.; excavation per cubic yard, 50c.

Moose Jaw Paving Co., Moose Jaw.—16 lb. treatment creosoted blocks, paving per square yard, $2.94; between tracks per square yard extra, 65c.; excavation per cubic yard, 69c.

National Paving and Contracting Co., Winnipeg.—Sheet asphalt, paving per square yard, $2.60; asphaltic concrete, paving per square yard, $2.55; paving between tracks per square yard, 70c.; excavation per cubic yard, 75c. E. B. Bonnell, city clerk.

North Battleford, Sask. — The Canadian Westinghouse Company have received the contract calling for the supply and erection of a 500 kw. generator and equipment, the price being $5,580.

North Battleford, Sask.—Messrs. Laurie and Lamb have received the contract to erect and furnish a 750 hp. steam engine, the price being $20,250.

North Battleford, Sask.—The contract calling for the erection and supply of a boiler has been awarded to Messrs. Babcock and Wilcox, Ltd., the price being $8,700.

Point Grey, B.C.—A $1,500 contract for the supplying of galvanized piping for use in extending the water supply system of the municipality has been awarded to Messrs. Robertson and Godson of Vancouver.

Quebec, Que.—Messrs. M. P. and J. T. Davis, contractors, have the contract for the structural work in connection with the Quebec Bridge, and are present making preparation for the sinking of the caisson required for the building of the main pier.

The Dominion Steel Company have the contract for the superstructure of the bridge, and are extending and fitting up their shops at Lachine for the manufacture of the larger metal parts.

Saskatoon, Sask.—Messrs. R. J. Lecky Company, Limited, Regina, have been awarded the contract for the erection of the new Knox Church. The cost of the building is estimated at $129,000.

Saskatoon, Sask.—The contract for furnishing material for and construction of Superstructure 23rd Street Subway has been awarded to The Dominion Bridge Co., Ltd., their price being $12,188. Other bidders and their prices are: The Canadian Bridge Company, $15,200; The Canada Foundry Company, $11,520 (this tender did not include ties, waterproofing, brick or concrete covering); W. M. Scott, of Winnipeg, $13,400.

Saskatoon, Sask.—The contract for plumbing and heating in connection with the seven-story Ross Block to be erected on Third Avenue has been awarded to Thomson and Homer.

Saskatoon, Sask.—Messrs. Shannon Bros. & Cassidy secured the contract to build the new King George Hotel at a sum of $127,000.

The same firm also received the contract to build the new Westmount School. Both schools will contain fourteen rooms and will be of brick construction. Tenders other than the winning one on the King George School are: Smith Bros. and Wilson, $127,000; D. A. Black, $133,920; and Bigelow Bros., $137,700.

The tenders on the Westmount School including the winning tender of Shannon Bros. and Cassidy, are A. W. Bell, $114,000; Dinnie Construction Company, $119,000; Shannon Bros. and Cassidy, $128,395; Lyall Mitchell Company, $128,500; Smith Bros. and Wilson, $128,500; D. A. Black, $142,900; and Bigelow Bros., $149,800.

Thorold, Ont.—The contract for the erection of the Ontario Pulp and Paper Mills, Thorold's new million-dollar industry, was let to the Lackawanna Bridge Co., of Buffalo, and work will be started on the industry in the course of a couple of weeks. The mills, when completed, will manufacture news print paper exclusively. They will turn out from 120 to 130 tons every twenty-four hours.

The machines are to be the largest ever built, and are now well under construction by the Husey and Jones Company, of Wilmington, Del.

The mill will be operated entirely by electricity, requiring about ten thousand horse-power, which will be secured from the Ontario Power Company at Niagara Falls.

Winnipeg, Man.—St. John's College has let to Worsick Bros. the contract for the erection of a new college building at a cost of approximately $40,000.

RAILWAYS—STEAM AND ELECTRIC.

Province of Alberta.—At a meeting of the directors of the Alberta Central Railway held in Ottawa, the name was changed to the Dominion Central Railway owing to the fact that the road has now a Dominion charter.

Future plans of the road were discussed and it is the intention of the promoters to build a line north and south through Alberta connecting across the boundary with the Great Northern and Northern Pacific. The road will run along the slope of the mountains with feeders east and west.

Central Ontario.—The Lake Erie and Northern Railway project, with a line to Port Dover from Brantford, via Simcoe, and from Brantford to Galt via Paris, is now assured, providing by-laws carry in the various municipalities for debenture stock.

Hamilton, Ont.—A report has been presented to the municipal council dealing with the entrance of the Canadian Northern Railway to this city. The City Corporation did not look with favor on the proposed entrance and passed a resolution to that effect, but mentioned that an alternate route as proposed by City Engineer Macallum, might be adopted without resistance from the Corporation. This route leaves the line proposed by the company southerly of its intersection with the main line (London branch) of the Grand Trunk Railway and proceeds then across Cook's Paradise to the westerly side thereof, connecting with the Toronto, Hamilton and Buffalo Railway, near Main Street, crossing underneath the streets of the city as far easterly as Wentworth Street.

Toronto, Ont.—The municipal council have decided to spend the sum of $35,000 in obtaining a report on the best solution of the transportation problems of this city; also to appoint a railway expert for the legal department of the city. This latter appointment and the traffic experts are to be Canadians if suitable men apply for the positions.

Western Ontario.—A report states that the proposed electric line the Messrs. Mackenzie and Mann are contemplating building will come to Exeter via Stratford and St. Mary's, and from there go to Lake Huron. It is proposed to have the terminal on this lake located at Brand Bend.

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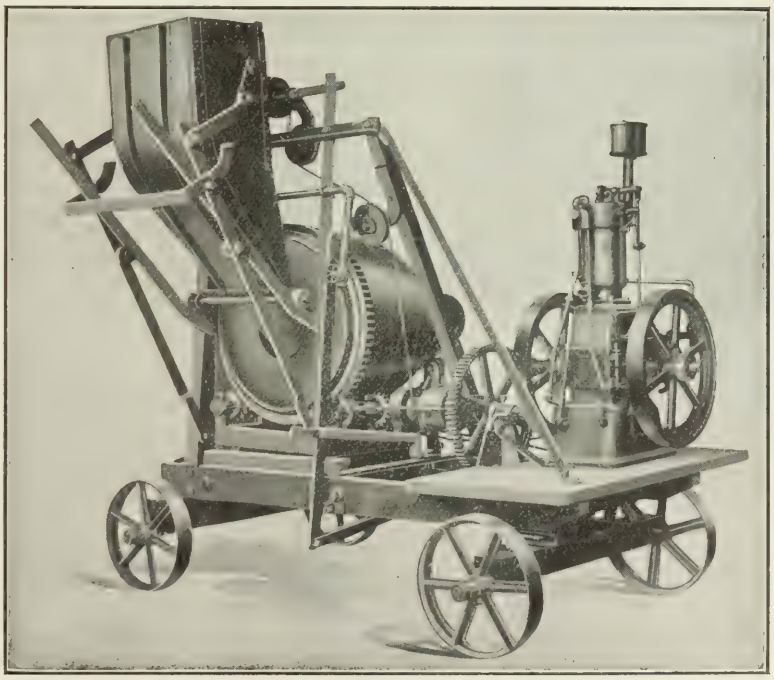

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LIGHT, HEAT AND POWER

Montreal, P.Q.—It is announced by the Montreal Light, Heat and Power Company, that beginning July 1st a further reduction in gas and electric rates will be effective. Gas will be sold at 95 cents per 1,000 cubic feet. The present price is $1. Electric lighting is to be seven cents per kilowatt hour as compared with 7½ cents at present.

Moose Jaw, Sask.—A report coming from Sask toon states that the power-house in Moose Jaw has been destroyed by fire, that the city is without electrical conveniences, and that there is a danger of the water supply failing.

District of Rainy River.—The Department of Public Works has ordered an investigation by departmental engineers of the water power situation along the Rainy River.

GARBAGE, SEWAGE AND WATER.

Bassano, Alberta.—At a meeting of the town council, May 6th, the John Galt Engineering Company of Winnipeg and Calgary were appointed engineers for the installation of a waterworks and sewerage system which will cost approximately $150,000. The by-law covering same will be voted on in the near future. A short description of this system will be found in our issue of March 21st, page 439.

Kincardine, Ont.—The Water and Light Commissioners of this municipality have decided to dispose of one steam pumping engine or exchange the same for a new pump.

Toronto, Ont.—The Toronto Board of Trade is not favorable to the city's acceptance, without further question, of the plan of the board of expert engineers calling for an eight million dollar expenditure on waterworks. They will recommend that the question of securing a perpetual supply from Georgian Bay be considered; also that the expert who installed a water system in California, bringing water for hundreds of miles, be engaged to make a report.

BUILDINGS AND INDUSTRIAL WORKS.

Crabtree Mills, P.Q.—Plans and specifications are being prepared for alterations and extensions and new dam for Messrs. E. Crabtree & Son, Limited, paper manufacturers, Crabtree Mills, P.Q.

Fort William, Ont.—The management of the Page-Hersey Company, who have taken over the agreement made between the Corporation and F. V. Samwell regarding a tube works, intend commencing construction operations on a plant in the course of a few weeks. The address of the Page-Hersey Company is Galt, Ont.

Magog, P.Q.—Plans and specifications are being prepared for a new weave shed, for the Dominion Textile Company, Limited, by T. Pringle & Son, Limited, Industrial engineers.

Medicine Hat, Alta.—Operations are to begin immediately on the erection of the new building for the Medicine Hat Milling Company.

Montreal, P.Q.—The firms and prices tendering on the erection of the new City Hall Annex, are as follows:—$649,000, made by the Peter Lyall & Sons Company, Limited; the next lowest being that of C. E. Deakin, $678,000, and the highest that of Mr. Joseph Bourque, $725,000.

Montreal, P.Q.—Plans and specifications are being prepared by T. Pringle & Son, Limited, Engineers, for extensions to reclaim plant for the Canadian Rubber Company, of Montreal, Limited.

Montreal, P.Q.—Plans and specifications are being prepared by T. Pringle & Son, Limited, Industrial Engineers, for a new slasher house for the Dominion Textile Company, Limited, Hochelaga Branch, Montreal.

Montreal, P.Q.—T. Pringle & Son, Limited, Industrial Engineers, are preparing plans and specifications for a manufacturing plant for "The N. K. Fairbank Company," Cote St. Paul, Montreal.

Moose Jaw, Sask.—Plans have been completed by Messrs. Reid & McAlpine, for the erection of a new building for the Young Women's Christian Association. The building will be three stories and basement, and of considerable size.

Nelson, B.C.—The management of the Dominion Saw Mill Company will erect a new mill on the site of the Yale-Columbia plant which was destroyed by fire last March.

Newcastle, N.B.—The municipal council are preparing to erect a new court house at an approximate cost of $31,000. Mr. Fairns is architect to this committee.

Ottawa, Ont.—The management of the Ottawa Gas Company are planning to increase the output of their plant by the erection of large subsidiary works. These works are to be placed on eight and one-half acres recently purchased by the company in the eastern part of the city.

Saskatoon, Sask.—The Winnipeg Paint & Glass Company are making preparations for the erection of a warehouse in this city. The new building will be metal clad 50-ft. x 100-ft. Mr. J. S. McDiarmid, Winnipeg, is interested in this matter.

Three Rivers, P.Q.—Plans and specifications are being prepared by T. Pringle & Son, Limited, Industrial Engineers, for a new cotton mill plant at the St. Maurice Valley Cotton Mills, Limited, at this point.

Toronto, Ont.—The Canadian Fairbanks-Morse Company, Limited, Toronto, are planning the erection of a large tractor shop on their property at Bloor Street West, Toronto. The plans and specifications for this building are being prepared by T. Pringle & Son, Limited, Industrial Engineers.

Welland, Ont.—The Cataract Rubber Company, Limited, has been incorporated with a capital stock of $250,000, and will locate its factory in Welland. The provisional directors are E. J. M. Block, of Buffalo; Jacob Dilcher, of Buffalo; and Myrtle A. Overholt, Col. L. C. Raymond and L. B. Spencer, of Welland. The company will manufacture rubber tires of all kinds and other rubber goods.

BRIDGES, ROADS AND PAVEMENTS.

Helena, Ont.—A steel bridge in course of erection on the line of the Grand Trunk Railway, collapsed. A break in a steel brace allowed a section of the structure to fall.

Ottawa, Ont.—There is a probability that Spark Street will be paved with asphalt during the coming season.

Orillia, Ont.—A petition calling for the paving of four blocks on the Main Street is receiving attention from the council. The cost of this work is estimated at $58,000.

York County, Ont.—A deputation from Pembroke, Ont., made an inspection of the work of the York County Commission for the purpose of securing first hand information on county road improvements to be placed before the ratepayers of Renfrew County in an attempt to encourage similar work in that division.

FIRES.

River St. Lawrence, P.Q.—The steamer "Iona," from Kingston to Montreal, was burnt and sunk in this river on May 18th last. The ship was loaded with soft coal and was owned by the F. E. Hall Company, of Montreal. The loss is estimated at $20,000.

St. John, N.B.—Messrs. Hutchings & Company, and Messrs. Patterson & Company had their plants destroyed by fire recently. The first-named company are bed and mattress manufacturers, the other engaged in the printing business.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending May 13th, 1912:—

A London firm manufacturing chairs and tables make inquiry for the names of Canadian manufacturers of turned goods, suitable for common wood chairs, such as turned spindles, stretchers, chair seats, etc.; the firm are also in the market for supplies of Canadian beech.

A London firm manufacturing printing inks, litho colors, litho varnishes, relief stamping colors, relief stamping varnishes, etc., wish to appoint Canadian representatives.

A Scottish firm manufacturing breast drills, diaphragm pumps, semi-rotary pumps, and chucks for vertical machines and lathes, desire to get into touch with Canadian buyers.

THE TRIPLEX BLOCK

A Triplex Block hung from a temporary rigging and used for laying pipe.

What is the Life of a Triplex Block?

WE don't know. Triplex Blocks built by the Yale and Towne Co. at the very beginning—twenty-five years ago—are still in actual use. The Triplex Block of to-day possesses greater lasting powers. With its steel parts—its chain superior to any other—its non-wearing gear movement—and the guarantee of a rigorous test before shipment under a fifty per cent. overload. It will outlast the man who buys it, no matter how young he may be.

The Canadian Fairbanks-Morse Company

LIMITED

Fairbanks Standard Scales — Fairbanks-Morse Gas Engines
Safes and Vaults

MONTREAL ST. JOHN OTTAWA TORONTO WINNIPEG
CALGARY SASKATOON VANCOUVER VICTORIA

A Yorkshire firm manufacturing hot water boilers and radiators are open to correspond with Canadian buyers.

A Danish correspondent asks to be placed in touch with Canadian manufacturers of building materials open to do business with Denmark.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:—

A London firm who are buyers of old scrap copper, brass, gun metal, etc., would be glad to receive offers from Canadian exporters.

CURRENT NEWS.

Nelson, B.C.—A new powder magazine has recently been completed for the Giant Powder Company. It is constructed of fire and weather proof brick and concrete, and fitted with a complete system of lightning conductors and bullet proof steel doors, powder and cap magazines. An 800-ft. approach from the water and the railway to the buildings has also been constructed.

The powder magazine is 22 by 32 feet and the cap house is 8 by 10 feet in size. Each building has a double room, the inside filled with earth and the covering being of asbestos. Lightning conductors have been installed at all the corners of the buildings and doors, which are of 8-plate steel, and all other metallic work are electrically connected with these conductors. The magazine will accommodate between two and three carloads of powder. The cost of buildings and approach is in the neighborhood of $4,000.

Province of Quebec.—A great deal of field work will be done this coming season in geological and mining investigations in the Province of Quebec, by both the Dominion Department of Mines and the Provincial Mines Branch.

The following programme has been settled upon:—

The Dominion Geological Survey will send two exploring parties in North-western Quebec. One of these will investigate the mining possibilities of the country to the east of the Bell River, between Grand Lake Victoria and Lake Mattagami. The other party will operate along the Nottaway River, from Lake Mattagami northwards. This is along one of the most likely routes for the projected Montreal-James Bay railway.

Another Geological Survey party will continue the work begun two years ago in Brome and Mississquoi counties, mapping out in detail the geology of the region.

Mr. J. Keele, of the Federal Geological Survey, who has made a specialty of the investigation of the clay deposits and industry, will begin a scientific inventory of the clay and shale resources of the province. The importance of this work may be gathered from the fact that last year the value of the products of the clay industry of the province of Quebec exceeded $1,500,000. A large quantity of clay is imported from New Jersey for the manufacture of pottery, drain-pipe, glazed tiles, etc., and it is quite possible that this investigation may result in the discovery of clays suitable for these purposes in this province.

The Dominion Mines Branch will begin a study of the peat deposits, and will report on their suitability for fuel purposes. The province of Quebec, unfortunately, does not possess coal deposits and is dependent upon Nova Scotia and Pennsylvania for its supply of fuel.

The Quebec Mines Branch will send out two parties. One of these will investigate the mineral resources of the region of the head-waters of the Harricanaw River, in North-western Quebec, whence has come the rumor of important mineral discoveries. Another party will continue the inventory of iron resources, which was begun last year. These two parties will be respectively in charge of Dr. Bancroft, professor of Geology at McGill University, and Mr. E. Dulieux, professor of Mining Engineering at Polytechnic School of Laval University.

STREET RAILWAY ENGINEER WANTED.

The City of Brandon are calling for applications up to June 10th, for the position of Street Railway Engineer. Applicants for the position must have constructing and operating experience in street railways, and must be prepared, if necessary, to form a part of a public utility commission for the City of Brandon. The advertisement for the position will be found in this issue of The Canadian Engineer.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16435—May 3—Approving location of G.T.P. station to be erected at Fraser Lake, B.C., mileage 359 from Prince Rupert.

16436—April 23—Authorizing G.T.P. B.L. Co. to cross highway and divert road on its Cutknife Branch, Saskatchewan.

16437—May 2—Dismissing complaint of J. O. Hall, of Toronto, re G.T.R. train connection at Belleville for Madoc, Ont.

16438—May 2—Refusing application of C.P.R. to vary terms of Order 15777, Jan. 8th, 1912, re Goderich interchange.

16439—May 2—Dismissing application of Ontario Malleable Iron Co., Ltd., Oshawa, re C.N.O. Ry. spur for manufacturers.

16440-41—April 26—Approving by-law of Kootenay and Alberta Railway Co authorizing S. T. Maines, Traffic Manager, to prepare and issue tariffs of tolls and approving Standard Freight Tariff, C.R.C., No. 1.

16442—May 3—Extending for six months time for filing by Esquimalt & Nanaimo Ry. revised Standard Tariff of freight tolls.

16443—May 3—Authorizing Algoma Central & H. B. Ry. to construct branch line on Michipicoten Branch.

16444—May 2—Directing that C.P.R. protect Lansdowne Ave. crossing, Toronto, Ont., with gates within 30 days, 30 per cent. by city, 30 per cent. railway, 20 per cent. by Canada Foundry Co., and 20 per cent. from Railway Grade Crossing Fund.

16445—May 3—Authorizing C.P.R. to construct spur for Messrs. Skinner & Miquelon, Calgary, Alberta.

16446—May 4—Authorizing C.P.R., and approving location of station to be erected at Craven, Sask.

16447—May 6—Authorizing C.N.R. to connect its lines temporarily, during construction, with C.P.R. near Dalziel Station, in Twp. of Lyon, and Dist. of Thunder Bay.

16448—May 4—Approving plan "A" of G.T.R. crossing of Burford and Mount Pleasant Roads, near Brantford, Ont.

16449—May 1—Authorizing C.N.R. to cross with its Swift Current Extension 14 highways in Saskatchewan.

16450—May 6—Authorizing town of Welland to construct Major Street across G.T.R.

16451—May 3—Directing that C.N.R. pay cost of changes in interlocking plant near Ottawa, operating and maintaining to be divided equally among N.Y. & O.; C.P.R.; G.T.R.; C.N.R.

16452—May 6—Rescinding Order No. 15994, dated Feb. 17, 1912, and naming revision in express delivery and collection limits for Kamloops, B.C.

16453—May 6—Directing Railway Companies to charge certain rates on coke in carloads of 30,000 minimum, tariffs to become effective not later than June 1st, 1912.

16454—May 6—Approving revised location of Campbellford, Lake Ontario & Western (C.P.R., mileage 134.68 to 155.66.)

16455—May 7—Approving location of Niagara, Welland & Lake Erie Ry. between G.T.R. tracks on East Main St., Welland, and M.C.R. tracks on South Main St., same town, 1¼ miles.

16456—November 7—Authorizing C.N.O. Ry. to cross with its tracks the C.P.R. spur to Mimico, in Twp. of Etobicoke, interlocker to be installed; whole cost by C.N.O. Ry.

16457—May 7—Authorizing G.T.B. B.L. Co. to cross with its Calgary Branch 2 highways in Alberta.

16458—May 6—Approving location of 8 stations of G.T.P. B.L. Co. Biggar-Calgary Branch.

16459—May 6—Authorizing C.P.R. to re-construct bridge 83.2 and 79.1 on its London and Windsor S.D. Ontario Division.

16460—Authorizing C.P.R. to construct spur for Inland Coal and Coke Co., Ltd., at Merritt, B.C.

16461—May 7—Authorizing C.P.R. to use and operate bridges Nos. 2.6 and 10.6 on Crow's Nest Division.

16462—May 7—Approving location of Central Rly. Co. of Canada, from village of St. Eustache to village of Oka, mileage 16 to mileage 31, in County of Two Mountains, Que.

16463—May 7—Authorizing Campbellford, Lake Ont. & Western Ry. (C.P.R.) to cross with tracks at mileage 87.86 from Glen Tay over C.N.O. Ry. spur line in town of Trenton, Ont.

16464—May 7—Authorizing C.P.R. to construct its track across highway at mileage 5, Mission S.D., B.C.

16465—May 7—Authorizing C.P.R. to construct spur into premises of George Minger, at Titian, Alberta.

16466—May 7—Authorizing Central Vermont Ry. to make connection with C.P.R. spur line into Farnham Military Camp, Farnham, Que.

16467—May 7—Authorizing C.N.O. Ry. to cross Weston Plank Road, Toronto, by means of a subway.

16468—May 6—Naming express delivery and collection limits for Toronto, Ontario.

16469—May 6—Authorizing Thomas Davies, of Toronto, to construct over-head crossing over C.P.R., in Lot 6, Twp. of Nipigon, Dist. of Thunder Bay, Ont.

16470—May 9—Approving location of C.N.R. through Twps. 16-17, Range 26, west 2nd M., and part of city of Moose Jaw, Sask., mileage 84.25 to 87.13.

16471—May 4—Approving Campbellford, Lake Ont. & Western (C.P.R.) location, mileage 124.83 to 125.5, and revised location from mileage 127 to 134.68, Twp. of Hope, Ct. Durham, Ont.

16472—May 9—Authorizing C.P.R to cross with its Pheasant Hill Branch 19 highways in Manitoba.

16473-74—May 8—16475-76—May 9—Approving revised location of C.N.O. Ry. (Montreal-Port Arthur Line), through Twp. of Davis, Dist. of Nipissing, and of C.N.O. Ry. revised location at Callander, Twp. of Ferris, and Dist. of Nipissing; and of C.N.O. Ry. (Montreal-Port Arthur Line), through Twp. of Pedley, Dist. of North Bay; and C.N.O. Ry. (Sudbury-Port Arthur Line), through unsurveyed territory in District of Thunder Bay, mileage 149.85 to 161.03 from Port Arthur.

Volume 22 Toronto, June 6, 1912

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The Canadian Engineer

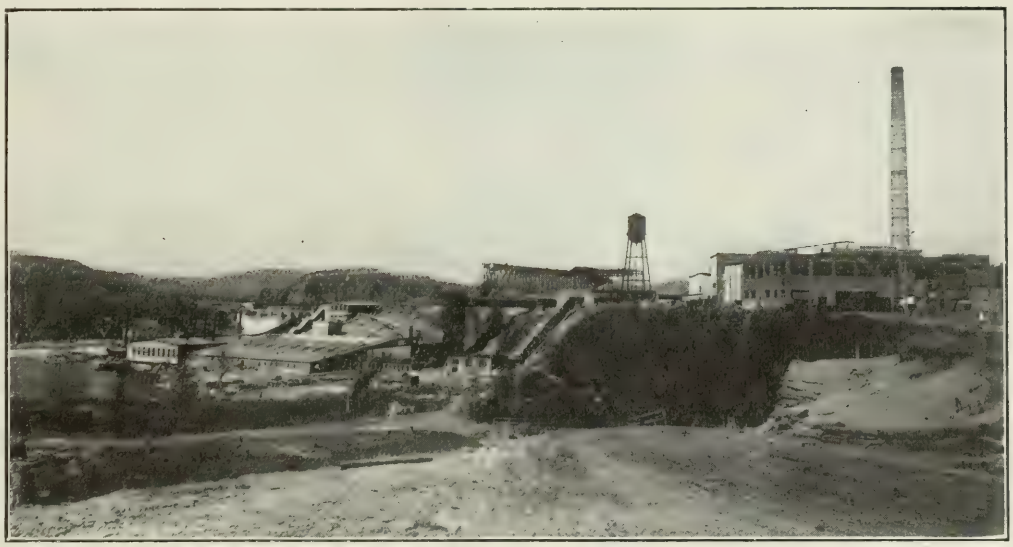
An Engineering Weekly

THE PLANT OF THE SPANISH RIVER PULP & PAPER MILLS LIMITED

The Spanish River Pulp & Paper Mills, Limited, are well located to meet the object they have in view. To Espanola, where are situated the company's mills, the Spanish River runs through the heart of the wood pulp country, its tributaries reaching practically every portion of the six thousand square miles comprised in the company's holdings.

Espanola is located on the Soo branch of the Canadian Pacific, forty miles west of Sudbury and 138 miles east of Sault Ste. Marie.

The company's timber lands consist of practically six thousand square miles, covered with the best grades of spruce and jack pine, balsam and poplar. The wood operations are carried on in the winter and in the spring; all the timber cut during the cold months is driven direct to the booming ground by means of the Spanish River, which, with its tributaries, drains the concession.



General View of Plant.

When the logs have been driven down the streams and rivers into proximity to the mills, provision has been made for their reception. At Espanola the Spanish River runs between two promontories. A sixty-foot head of water was obtained by placing a concrete dam across one branch. The penstocks lead away from this dam to the power-house, being controlled by gates operated by hand power, the mechanism being placed on the top of the dam. At one end a spillway is provided for getting rid of ice, logs, etc.

The manufacturing process commences when the logs first leave the booming ground. At this stage they vary in length from eight to sixteen feet. As they emerge from the booming ground the logs are raised on an inclined cable until they are on a level with a sixteen-foot slasher contained in a solid brick building far above the level of all the other buildings comprising the pulp plant. The slasher cuts all the logs into two-foot lengths. The dissevered logs, without any handling, drop directly from the slash table into a cable storage conveyor, which is six hundred feet long and sixty feet high. The wood, when it reaches the topmost altitude, drops into piles, where it remains until the time comes to feed the blocks into the barking machines. A supply has to be created to keep the mill going throughout the winter months, and there is a storage capacity for 40,000 cords of wood. The cost of taking the logs from the water, sawing them into two-foot lengths and storing them, is less than 15 cents a cord. This is the only saw slasher of its kind in use, as it was designed by the company's staff.

The logs are conveyed from the storage pile to a room situated on the brink of the hill overlooking the pulp mill proper. Here the rough knots and the bark are removed by means of barking machines operated by motor. The shavings and waste from the wood are mechanically conveyed by blowers to the boiler house. The barked wood, in its turn, is delivered to the grinder house by means of a short conveyor and a large gravity slide. At the bottom of this slide the logs find their way into a tank of water, where they remain until they are ready to be placed in the grinders.

The grinder room is situated in the northern part of the main pulp mill. Twenty-four grinders are in use and these are driven by water-wheels. When the logs have been reduced to the consistency of pulp, the pulp, greatly reduced in consistency by means of water, is conveyed to a large concrete tank by means of gravity. The grinders and water-wheels used in this process are set upon heavy concrete and steel foundations.

Over a period of five years, the maintenance of water-wheels and grinders has not exceeded fifteen cents per ton.

In the screen room the diluted pulp is conveyed by gravity through two sets of screens, passing thence in a

steady flow to storage tanks in the machine room. In the machine room there are eighteen 84-inch wet machines. The pulp flows in at one end of these in the consistency of milk, though the color is of a creamy shade, and re-appears at the other end in sheet form. These sheets are piled on iron trucks with wire mats between each sheet.

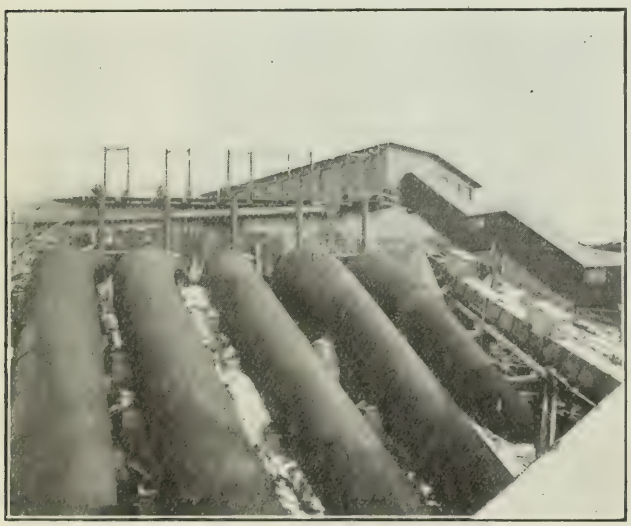
When the truck has been piled up to the height of several feet, it is rolled into one of the hydraulic presses, a pressure amounting to 450 tons being there applied. After the exertion of this pressure 58 per cent. of the pulp is dry. The pulp is then conveyed by means of an elevator to the upper level, where it is loaded into cars for shipment.

The pumping station contains two turbine water pumps, possessing a capacity of 6,000 gallons per minute. These pumps are used for supplying the paper plants with water. In addition are two turbine stock pumps, similar in capacity, which are used for pumping the ground woodpulp from the pulp mill on the lower level to the paper mill above. A booster pump is contained in the pumping station, electrically driven, which will be used for fire protection, and there is also a steam pump, to meet the requirements of the underwriters. with a capacity of 1,500 gallons per minute.

Pulp Mill, Showing Hydraulic Presses at Work.

The buildings comprising the new paper mill are all located so as to reduce the cost of manufacture, and the internal fittings are modern and complete. The filtration house has sufficient capacity to filter all the water to be used in both the pulp and paper mills. The water supply taken from the canal runs by gravity. A large freight elevator will be useful in the process of loading the company's output into cars. A storage building has been provided for the chemical pulp, a portoin of its basement to be used as a machine shop. The building containing the beater room has in its basement two ground woodpulp slush chests, on top of which are placed machines to abstract the water from the pulp, and to discharge the thick pulp into the chest ready for the beaters. Between the two chests mentioned are electrically driven pumps, which pump the thick pulp to the beaters above, thus eliminating any handling by labor.

In another portion of the building are found round concrete tanks, two of which are used to put the paper stock into and from the beaters, the whole being carried thence to the paper machines. In the basement are located two pumps, used to handle the paper stock from the tanks to the Jordan engines. The eight beating engines are in two units, and each unit is driven separately by a three hundred h.p. motor. On the second story are eight beaters, each of a capacity of one ton, and these are used to prepare the paper stock for the paper machines. The two large Jordan engines which are used to refine the paper stock after it has peen prepared by the beaters are directly connected to electric motors.



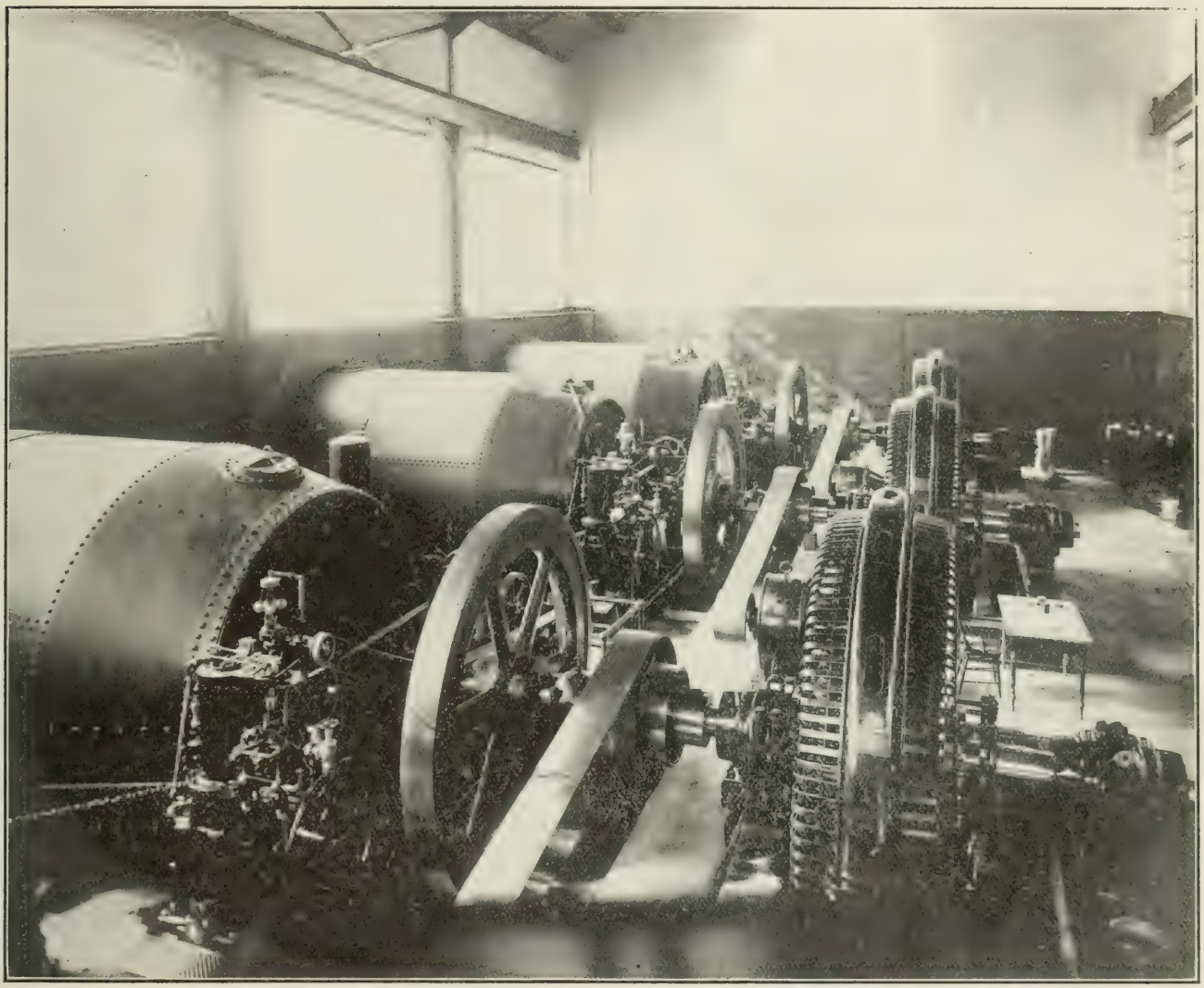
View Showing Penstocks with Gate Mechanisms Showing Above Dam.

Interior View of Paper Mill, Showing Two Paper Machines Installed.

The paper machinery is in the central building, which is 276 feet long by 82 feet wide. In the basement of this building are eight large suction pumps, two large stock pumps, and the necessary water pumps. To propel at variable speed the paper machines two six-hundred h.p. steam engines have been provided. The exhaust steam from these engines will be used to apply heat for the drying of the paper. In order to eliminate the handling of broken paper by labor, a beater has been placed in the basement, and after the broken paper has been treated it will be pumped once more into the stock tanks. On the second story are two Fourdrinier paper machines of the latest type. Each of these machines is capable of manufacturing a sheet of newspaper 156 inches wide, at 600 feet per minute. Each machine will have a capacity of 50 tons daily. At the north end of the machine room a gallery has been arranged, which contains four pneumatic save-alls. The water from the machines is pumped to these save-alls, and in this manner every particle of stock that the water contains is saved. A system has been arranged for the economic handling of the paper product from the machine to the finishing room.

The building in which the paper product is finished is 154 feet long and 92 feet wide. The upper story is used to finish the rolls of paper, while the lower story is designed exclusively for storage. Railroad tracks have been installed on each side of the building, with loading platforms designed for the economical loading of the paper into cars.

All the buildings connected with the paper plant are equipped with steel window frames, concrete window sills and steel lintels, with single and double glazing. The entire design of the buildings was considered with a view of installing two more paper machines at a later date, which, in view of the arrangements made, may be done at small expense. A steel water tank, 100 feet high, possessing a capacity of 50,000 gallons, has been erected, thus assuring the company in its operation a continuous supply of water pressure, as well as good sprinkling system in case of fire. Cast iron water mains have been laid round the entire plant, and a large number of hydrants, hose houses and reels have been provided, arrangements which have met with the entire approval of the Fire Underwriters.



General View of Interior of Power House, Showing Arrangement of Turbines and Generators.

The paper mill, now being completed, will give the company the following production:—

Newspaper	100 tons daily
Mechanical pulp	107 " "

Provision has been made so that the paper mill capacity can readily be doubled at minimum capital expenditure.

The hydraulic and steam power equipment will be described more fully in a succeeding article.

NEW BUILDING BY-LAW FOR TORONTO.

(Continued from last week.)

(7) In all cases where reduction in the bending moment is allowed on account of continuous action, sufficient steel reinforcement must be provided in the top of the slab or beam over the support to meet the requirements of the accepted theory of flexure, and this upper reinforcement shall extend on both sides a sufficient distance beyond the centre of the support to develop adhesion equal to at least the strength of the upper bars on the basis of the allowable unit stresses.

(8) If the girders, beams and slabs are poured in one continuous operation, then the girders or beams may be treated as T-beams with a portion of the slab acting as a flange. In no case shall the overhanging width on each side of the girder or beam exceed four times the thickness of the slab and the total width of the flange shall not exceed five times the width of the girder or beam.

(9) In beam and slab construction an effective metallic bond shall be provided at the junction of the beam and slab and where reinforced concrete girders carry reinforced beams, the portion of the floor slab acting as flange to the girder must be sufficiently reinforced with bars near the top, at right angles to the girder, to enable local loads to be transmitted directly instead of through the beams to the girder, thus avoiding an integration of compressive stresses due to simultaneous action as floor slab and girder flange.

(10) In the design of T-beams acting as continuous beams, due consideration shall be given to the compressive stresses at the support at the bottom of the beam.

(11) When the overall vertical distance of the tension members of a girder or beam is greater than one-sixth of the total depth of the girder or beam, the stresses in members shall be computed in proportion to the distance from the neutral axis.

(12) Shrinkage and thermal stresses must be provided for by the introduction of steel.

Proportion of Concrete and Allowable Stresses on Concrete and Steel.—12.—(1) All concrete for columns, girders, beams, slabs, walls, fireproofing or piles shall be composed of materials meeting the requirements of these regulations, and be mixed as hereinbefore specified, in the proportion of not less than one part of cement to two parts of fine aggregate and four parts of coarse aggregate, or in such other proportions as may be necessary to make the resistance of the mixture to crushing not less than two thousand (2,000) pounds per square inch after hardening for 28 days.

(2) Tests to determine this value must be made at the expense of the contractor when required by the inspector of buildings at a place and by a person satisfactory to him and under the direct supervision of either the said inspector of buildings or a person representing him.

(3) When the proportion of cement is increased and the quality of aggregates hereinbefore called for used, an increase may be made on the allowable working stresses proportional to the increase in compressive strength at 28 days as determined by actual tests, but this increase shall not exceed 25 per cent. On this basis the following maximum stresses for 1:2:4 concrete will be allowed in construction:

(a) Compression in extreme fibre of girders, beams and slabs, 600 pounds per square inch.

(b) Direct compression, 450 pounds per square inch.

(c) Shearing stress, when diagonal tension is not resisted by steel, 40 pounds per square inch.

(d) Shearing stress, when all diagonal tension is resisted by steel, not to exceed 100 pounds per square inch of effective cross section.

Members of web reinforcement shall be designed so as to adequately take up all involved stresses throughout their entire length. They shall not be spaced to exceed three-fourths of the depth of the beam in that portion where the web stresses exceed the allowable shearing value of the concrete.

Web reinforcement, unless rigidly attached, shall be placed at right angles to the axis of the beam and looped around the extreme tension member.

(e) For tee-beams the width of the stem only shall be used in calculating the shear.

(f) Adhesion to plain steel bars, 60 pounds per square inch of surface of bar.

(g) Adhesion to deformed steel bars, up to 100 pounds per square inch of surface of bar may be permitted.

(h) For compression in columns with not less than 1 per cent. and not more than 4 per cent. of longitudinal reinforcement, the safe load shall be computed as follows:

Safe load (in pounds) = 450 (Ac+15 As).

Ac = Net cross sectional effective bearing area of concrete in square inches.

As = Cross sectional area of longitudinal reinforcement in square inches.

(i) For columns reinforced with both longitudinal steel and spirally wound hooping when the volume of hooping is equal to at least one per cent. of the volume of the enclosed concrete and the longitudinal reinforcement is not less than one per cent. and not more than four per cent. of the cross sectional area, the safe load shall be computed as follows:

Safe load (in pounds) = 650 (Ac+15 As).

Ac = Net cross sectional area of concrete enclosed in hooping in square inches.

As = Cross sectional area of longitudinal reinforcement in square inches.

(4) The foregoing allowed stresses shall be used only where the unsupported length of the column is not greater than 15 times the least diameter of effective bearing area. Where the length exceeds this limit, the allowable stress shall be reduced according to approved standard formula.

(5) Bending stresses due to eccentric loads on columns shall be provided for by increasing the section of concrete or steel until the maximum stress on a column will not exceed the allowable working stress.

(6) The least diameter of effective bearing is to be understood to mean the distance from inside to inside of hooping in columns with spiral hooping, and in others from outside to outside of longitudinal reinforcement.

(7) The pitch of spiral reinforcement shall not be greater than one-sixth of the effective diameter of a column, and in no case more than three inches, and adequate means must be provided to hold it in place as as to form a column, the core of which will be straight and well centred.

(8) When columns are reinforced with longitudinal rods only, the reinforcement shall be tied together with bands, having an area of not less than one-sixteenth of a square inch, placed not more than the effective diameter of the column apart or in any case not more than twelve inches. The bands to be jointed in such a manner as to do away with any liability of the reinforcement spreading, and shall be wired to each longitudinal rod.

(9) The percentage of reinforcement in any column, regardless of the load carried by it, is not to be less than one per cent. of the effective cross sectional area. Reinforcement to be in all cases placed at corners of square or rectangular columns, the minimum size of which shall be 9/16 inch round or ½ inch square steel rods.

(10) No column shall have less than sixty-four square inches of effective area or a dimension of less than eight inches.

(11) When longitudinal reinforcing rods in columns have an area in excess of one and one-fourth square inches the ends shall be faced or milled off normal to the longitudinal axis and such rods shall have full and perfect bearings and a tight fitting sleeve or other approved appliance shall be provided at each joint to keep the rods in their proper position.

(11) When longitudinal reinforcing rods in columns have an area of less than one and one-fourth square inches the rods may be lapped and securely wired together, the splice to be of a sufficient length to develop by adhesion the strength of the rod.

(13) All butted joints shall be made at the floor levels or at points where the columns may be considered as fixed, and the centre of lapped joints shall not be more than one foot above floor levels or points at which rigid lateral support is afforded the columns. The ends of all rods at the base of columns shall be made smooth and right angled from the longitudinal axis and such rods shall have a perfect bearing on a steel plate or casting of sufficient size and strength to distribute the load which the column supports to such an extent that the allowable compressive stress per square inch on the material under this plate shall not be exceeded, or in lieu of the plate the stress may be distributed in concrete footings to the required extent by means of dowels of sufficient length and area to sustain the weight by adhesion of the concrete to the steel, without exceeding the specified limit for such in this regulation. The tops of all dowels to extend to the top of the footing and be made perfectly level and smooth to receive the longitudinal reinforcing rods and the joint between the dowels and the rods to be made with a pipe sleeve which is to be grouted into the footing at least six inches and extend six inches above the top of same and the reinforcing rods after being secured in their proper position are to be solidly grouted into the sleeve with liquid Portland cement.

(14) The area required in footings which have to support columns having both spiral hooping and vertical reinforcement shall be obtained in a similar manner to that immediately above specified for columns with vertical reinforcement only. The longitudinal reinforcing bars in all columns shall be straight and sufficient metallic lateral support shall be provided to keep them in their proper place until the concrete in the column has set.

(15) The allowable stress on steel in tension shall be sixteen thousand pounds (16,000) per square inch.

(16) Where it is necessary to introduce steel to resist compression in girders, beams or slabs, the compressive stress per square inch allowed on such steel shall not exceed fifteen times (15) the computed compressive stress in the concrete at the same distance from the neutral axis. All such steel shall be anchored into the mass of concrete in such a way as to prevent any possibility of buckling.

13.—The minimum protection for steel reinforcement which is to be taken, is the distance from the surface of the steel to the nearest concrete surface, shall be:

(a) For girders and columns, two inches.
(b) For beams and lintels, one inch and a half.
(c) For floor and roof slabs, one inch.

Plain and Reinforced Concrete Walls.—14.—(1) Concrete walls without reinforcement, other than those of foundation or basement, shall be constructed with concrete of the same composition and quality in all respects to that hereinbefore specified for reinforced concrete, and shall be the full thickness prescribed in this by-law for brick walls.

(2) Buildings having a complete skeleton construction of steel or of reinforced concrete construction of a combination of both, may have exterior walls of reinforced concrete at least eight inches thick; provided, however, that such walls shall support only their own weight, and that such walls shall have both vertical and horizontal steel reinforcement on both sides, the rods to be placed not more than eighteen inches apart from centres, and be securely wired together at each intersection and rigidly connected with columns and girders. All rods shall be lapped a sufficient length to develop their full stress by the allowable unit stress for adhesion. Additional rods shall be set around openings, the vertical ones to be wired to the nearest horizontal ones, and the horizontal rods at top and bottom of openings wired to the nearest vertical ones. In all cases the percentage of steel reinforcement to be provided shall be sufficient to enable the wall to safely resist a uniformly distributed horizontal pressure by thirty pounds per square foot acting on either side of it, but in no instance shall the percentage of reinforcing metal be less than one-quarter of one per cent. in each direction. The thickness of a reinforced concrete curtain wall shall not be less than one-eighteenth of the unsupported height.

Tile and Reinforced Concrete Joist Construction.—15.—(1) When tile and reinforced concrete joist construction is used for floors, the tile shall be sound, hard burned, free from shrinkage cracks, or uniform size and corrugated in a horizontal direction upon the sides.

(2) The reinforced concrete joists shall be parallel and in perfect line and of sufficient width to develop the steel, which steel is to be protected from fire with concrete of a similar mixture and thickness to that hereinbefore specified for concrete beams. Should concrete be required on the top of the tile to take compressive stress it must be not less than two inches in thickness and must be poured at the same time at the joists, and be of the same mixture. The tile shall be thoroughly soaked with water before the pouring of the concrete is commenced. In this class of construction the dead and entire live loads will be assumed to be carried by the reinforced concrete joists.

16.—Upon the completion of a reinforced concrete building the architect or engineer who designed the structure shall issue a signed certificate and have the same posted in a conspicuous place on each floor, stating the safe capacity per square foot of floor space, if the entire floor is designed to carry the same load. If, however, the floor is designed to carry different loads, each section must be provided with a certificate stating the capacity of that particular section and describing the limits thereof.

17.—Load tests shall be made by and at the expense of the contractor when required by the inspector of buildings, under his direction and in his presence or in the presence of his representative, on any portion of a reinforced concrete structure within a reasonable time after erection. Such tests shall show that the construction will sustain a load of twice the live load for which it was designed without causing any permanent deformation.

18.—No system of reinforced concrete shall be used which is not capable of design and investigation in accordance with the formula and principles laid down in these regulations.

19.—Section 111 of By-law No. 4861, being "A By-law for regulating the erection and to provide for the safety of buildings," is hereby repealed.

Comments by the Citizens' Committee.—While the proposed by-law for regulating reinforced concrete construction in the city of Toronto is in the main satisfactory to the Citizens' Committee on the revision of the building by-law, there

are certain provisions to which exception is taken. In the opinion of this committee these should be amended before the proposed ordinance becomes law, if it is to represent the latest and best constructional practice.

To this end the committee wishes to make the following comments on the draft by-law, and offers corresponding suggestions for its improvement.

Section 2, sub-section 3, page 2.—It would appear from this that the weekly reports furnished the inspector of buildings are to concern only the records of the progress of concreting and the date of removal of forms. In the opinion of the committee it should be required to include also a declaration that, in the opinion of the inspector in charge, the work covered by the report has been executed in all respects in accordance with the plans, specifications and city building regulations.

Section 5, sub-section 3, page 7.—It is now recommended by the best authorities that test mortars shall show, not merely 70 per cent., but 100 per cent. of the strength of a similar mortar made with standard Ottawa sand.

Section 6, page 8.—The complete prohibition of Bessemer steel, high elastic limit steel and re-rolled steel for reinforcement, is in the opinion of this committee not warranted. If these materials are capable of passing the usual tests prescribed for them, their use should be allowed. Suitable tests for high elastic limit steel should be inserted in the by-law.

Section 7, sub-section 3, page 10.—In the interests of definiteness the volume of a bag of cement should be defined, and the committee recommends that this be fixed at 9/10 of a cubic foot.

Section 8, sub-section 11, page 12.—The minimum length of time which columns should be poured ahead of the floors should be defined.

Section 11, page 16.—The bending moments for slabs and beams fixed by this section are in excess of those required to be figured in the newer building codes of large American cities. With the careful inspection provided for in the regulations under discussion, it would, in the opinion of this committee, be entirely safe to reduce these requirements to conform to those recently adopted by the cities of New York, Chicago, St. Louis, Minneapolis and San Francisco. It is therefore recommended that for slabs and beams continuous over two or more supports the moments at the centre and at the supports be taken as 1/12 wl. and that for slabs and beams continuous over one support only, the moments shall be 1/10 wl. Corresponding alterations should be made in sub-section (4) to cover slabs reinforced in both directions and in sub-section (7) to conform with the above rules

Section 11, sub-section 6, page 18.—The reduction of reinforcing steel in slabs here prescribed is not in accordance with accepted theory. It is recommended that the steel be reduced at the support to 50 per cent. of that calculated per foot of width and that the reduction begin at the third points instead of at the quarter points.

Section 11, sub-section 8, page 18.—Where the slab extends on only one side of the beam, it should be allowed to flange up to four times its thickness.

Section 11, sub-section 10, page 19.—It is almost universal practice to allow compressive stresses at the bottom of a beam at the support, fifteen per cent. in excess of those allowed elsewhere in the beam. This should be permitted in the present regulations.

Section 12, subsection 3, page 20.—The allowable working stresses prescribed in this sub-section are lower than those permitted in the most recently adopted building codes of American cities. It is recommended that the compression on the extreme fibre of slabs, beams and girders be 650 pounds per sq. in. The corresponding stress in the codes of New York, Chicago, St. Louis, Minneapolis and Cleveland runs from 650 to 800 pounds per sq. in. For direct compression, the specified stress of 450 pounds per sq. in. is also lower than is now generally adopted. It is recommended that this be placed at 500 pounds per sq. in., the same as permitted in New York, St. Louis, Cleveland and Baltimore. The formula for safe loads on columns, paragraph (h), should be correspondingly changed.

Section 12, sub-section 6, page 22.—It is excessively severe, and beyond the present requirements of the City Architect's department to allow as effective diameter of a longitudinally reinforced column only the distance from outside to outside of reinforcement. Were this rule adopted it would mean that a 10 inch by 10 inch column would have an effective area of only 36 sq. in., or 36 per cent. of its area. It is customary to allow the full area in this class of columns. Sub-section 10 on page 23 should be altered to read: "Sixty-four square inches, outside area."

Section 12, sub-section 8, page 22.—For bends in columns having longitudinal reinforcement only, one-quarter inch rounds should be permitted spaced not farther apart than the outside diameter of the column. Since such material is of the nature of wire, and therefore very easily worked, its use should be allowed, as tending to ease and rapidity of construction.

Section 12, sub-sections 11-13, page 23.—In sub-section 11, it should be made clear that the area of one and one-fourth square inches is of individual rods and not the aggregate area. For rods having an area less than this, it should be allowable to use a pipe-sleeve joint without milling the ends of the rods, as an alternative to the lapped splice prescribed. Shore columns require to be reinforced for moment due to wind, it should be allowable to locate the splices at other places than at the floor levels.

Section 13, sub-section 15, page 24.—There is no good reason why the use of high elastic limit steel should be prohibited. It should be allowed to be stressed up to one-third of the elastic limit, but not over 20,000 pounds per square inch.

Section 14, sub-section 2, page 25.—The amount of reinforcement here required is excessive. Steel enough to resist a pressure of 30 pounds per square foot on either face of the wall is all that is necessary.

Section 15, sub-section 1, page 26.—Provision should be here made for concrete tile or other fillers than terra-cotta tile.

Section 18, page 27.—This would technically debar the use of any new system of construction without amendment of the by-law and therefore should be omitted.

It is recommended that for definiteness and convenience the values of R in the equation $M = Rbd^2$ be listed in the by-law for working stresses from 16,000 to 20,000 pounds per square inch, as indicated in the memorial presented to you in May last, section 19, page 52. Further, it is requested that the moment area be defined as 0.87 times the distance from the top of the beam to the centre of the steel for both rectangular and T-beams.

OTTAWA WATER SUPPLY.

The Pitometer Company, who recently made a water survey for the city of Toronto, have been employed by the city of Ottawa to make an extensive survey of the water mains of that city. Investigations will begin at once and will probably cover six or eight weeks.

RECENT DEVELOPMENTS IN PAINT TECHNOLOGY.*

By Henry A. Gardner.†

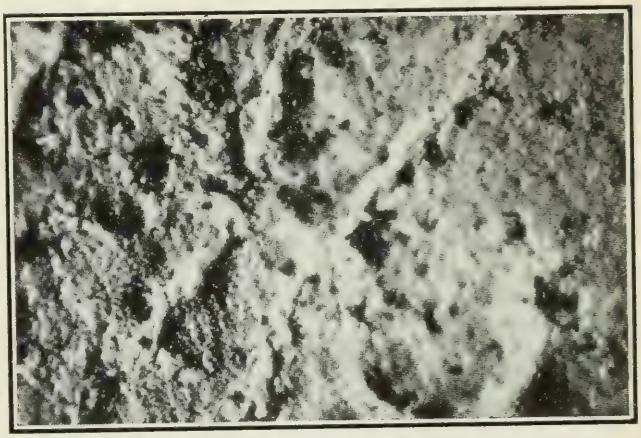
Lumber and Its Relation to Paints.—The proper choice and treatment of lumber is one of the most important problems which the builder as well as the painter has to face. When about to build a dwelling, barn, or other structure made principally of wood, the question is sure to arise in regard to what variety to select so as to get the maximum service and money value. The locality in which the structure is to be built must often have a bearing upon this question. While it is true that the painting of each type of wood demands the special consideration of the painter, it is also true that the study of paints for wood protection points toward the production of a paint that will give satisfactory results under all conditions and on all grades. It is the writer's opinion that a paint may be made that will be perfectly well suited for the preservation of every species of wood, provided the paint is properly treated in the hands of the skilful and intelligent painter, who can produce lasting results on almost every type, by varying the proportion of thinners and oil in the various coats. The painter who uses the same paint on soft pine and again on hard pine, without making a special study of how to reduce the priming coat for the hard pine, will be likely to get inferior results on the latter. In case of failure, the natural impulse is often to place the blame upon the paint, whereas the real responsibility may rest upon the painter's lack of knowledge.

Signs of Paint Failure.—Those who are responsible for the care and maintenance of property the familiar with the condition of surface presented by almost all wooden buildings or structures which have been improperly painted with inferior paints. "Chalking" or "flouring" are terms used to describe the condition of a paint surface which has deteriorated within the paint film. The formation of minute fissures generally spoken of as "checking," as well as the effects best described as cracking, scaling, peeling and blistering, are other signs of failure which cause paint coatings to present an unsightly appearance, and which point inevitably either to the use of improperly made paints or to improper application. The cause of these conditions is not difficult to understand when even a brief study of the character of the materials entering into the composition of a paint has been made. It is, however, a fortunate circumstance that the proper admixture of different types of pigments enables us to correct the strong tendency exhibited by special pigments to rapidly deteriorate in an oil film. This point will be more fully discussed in a later paragraph.

Requisites of a Good Paint.—Progressive manufacturers are aiming to produce a paint which will show, under the widest range of conditions, good hiding power, adhesiveness, freedom from internal strains, permanency of color, relatively high imperviousness to moisture, sufficient elasticity to prevent scaling or cracking when subjected to expansion or contraction, and freedom from the chemical action which results in deep checking or excessive chalking. Such a product as this cannot be obtained, in the writer's opinion, by the use of any one pigment in linseed oil. In order to meet all the demands as stated above, there should be in an economical and durable paint a proper percentage of the various pigments which, united, will tend to correct each other's faults, and thus produce a durable paint coating of maximum efficiency.

The Composition of Paints.—As is well known, a paint is a mixture of one or more pigments and a vehicle which acts the part of the spreading and binding medium. Up to the present time the vehicle portion of paints has generally been made of linseed oil, admixed with some volatile thinner, such as turpentine. The subject of oil and plant vehicles will be discussed more fully later on.

Physical Properties of Pigments.—The pigment portion of a paint for use on barns and farm buildings may, if desired, be composed of properly selected iron oxides or other colored pigments, even containing in some cases a moderately high percentage of silica, clay, or other inert materials, and give perfectly satisfactory results. For the preservation and decoration of dwellings, however, the pigment portion of paints is generally made as a whole or in part of the most expensive white pigments, such as white lead and zinc oxide. The relative values and properties of these white base pigments will now be taken up.



"Chalking."—Type of Decay Exhibited by Improperly Made Paint.

White Lead.—White lead, either of the corroded or sublimed type, is perhaps the most generally used of all the white pigments as a paint base. Corroded white lead is a basic carbonate of lead, while sublimed white lead is a basic sulphate of the same metal. Both of these types are white and admirably adapted as painting materials. They take relatively the same amount of oil and spread easily, producing paint films which are highly opaque and which, therefore, hide efficiently the surface upon which they are placed. Sublimed white lead is a relatively finer pigment than corroded white lead, and seems to show a tendency to chalk to a greater extent upon exposure to the weather. Corroded white lead is more alkaline, however, than sublimed white lead, and when used alone with linseed oil generally shows a tendency to chalk to a considerable extent in a short time and to show deep checking, thus permitting the admission of moisture. The alkaline nature of this pigment produces considerable action upon certain tinting colors and results in fading or darkening when mixed with delicate greens or blues.

The use of white lead has been condemned in some parts of this country, as well as abroad, because of its alleged poisonous properties. While it is true that lead poisoning may occasionally occur in some factories where the workman and his conditions are not properly safeguarded, it is, nevertheless, a fact that lead poisoning very seldom occurs among painters of experience and cleanly habits. Carelessness in mixing white lead is, fortunately, a practice almost obsolete among painters. The use of

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paints already ground in oil by means of machinery to a pasty condition, allowing easy working and reducing, obviates the danger of lead poisoning from any such cause as this, even though the percentage of lead in such paints is in preponderance.

Zinc Pigments.—Another pigment which has proved itself of great value to the painter is zinc oxide. The use of this pigment may be said to have almost revolutionized the paint industry of the world, and its increased consumption during the last ten years is sufficient evidence of its value as a painting material. Zinc oxide is produced by oxidation and sublimation of zinc ores and is not only extremely fine, but of great whiteness. It has good hiding power, although not quite so great as that shown by the white leads. It tends to produce a glossy surface, making it especially valuable for use on interior work and in enamels. When used alone it has the effect of hardening the oil film in which it is enveloped, and upon long exposure causes cracking and scaling. However, when the sublimed or corroded white leads are properly combined with zinc oxide, a more durable surface is produced, the shortcomings of each pigment being overbalanced by the good properties of the other. The proper combining properties of zinc oxide with white lead may be said to vary between twenty to fifty-five per cent. of zinc oxide for paints designed for exterior use. In the opinion of the authors, lead and zinc

"Scaling."—Type of Decay Exhibited by Improperly Made Paint.

pigment in the above percentage, properly blended and ground, make paints of far better wearing value than can be produced with either white lead or zinc oxide used alone.

Zinc-Lead.—Zinc-lead, a pigment sublimed from mixed lead and zinc ores, and containing about equal proportions of zinc oxide and lead sulphate intimately combined, as well as leaded zinc, a product similarly produced, but with zinc oxide running about seventy-five per cent., are white base pigments of value which are used to a considerable extent. They are generally slightly off color, however, and are therefore used most largely in paints which are to be tinted in various colors.

Lithopone.—Lithopone, a pigment produced by precipitation, and consisting of zinc sulphide and barium sulphide, is of great value in the manufacture of interior paints. On account of its liability to darken and disintegrate, however, it is seldom used on exterior work, although recent tests have shown that when used in combination with zinc oxide and whiting, it gives very promising results.

Crystalline Pigments and Their Use.—Barytes (barium sulphate), silex (silica), whiting (calcium carbonate), gypsum (calcium sulphate), asbestine (silicate of magnesia), and china clay (silicate of alumina) are white crystalline pigments which, when ground in oil, become transparent. All of these pigments possess the property of strengthening a paint film made of white lead and zinc oxide, and often increase the durability of such a paint. Barytes, silica, and china clay are especially valuable for this purpose. Asbestine, because of its needle-like structure and low gravity, prevents settling and acts as a reinforcer of paint films. Whiting or calcium carbonate should be used when zinc oxide is in excess in a paint, so that the hardness of the paint may be overcome.

A white paint must be possessed of sufficient opacity to efficiently hide the surface upon which it is placed, when three coats are applied for new work or two coats for repainting work. Mixtures of the white leads and zinc oxide, with the latter pigment running not over fifty-five per cent., will easily produce such a result and wear well. It is generally deemed advisable, however, by most manufacturers to take advantage of the excessive opacity of such mixtures, which allows the introduction of moderate percentages of these inert pigments which give greater strength and other desirable features to a paint. The percentage of natural crystalline inert pigments to add to a white paint made of lead and zinc must, however, be moderate and insufficient to detract materially from the hiding power of the paint.

White-Paint Formulas.—From these conclusions, which have come from wide experience in the testing of paints under actual service conditions, there can be recommended to the buyer of paints and to the manufacturer and master painter those machine-mixed paints in white, made by reputable manufacturers, the composition of which will show a mixture of white lead and zinc oxide, with the latter pigment within limits of between fifteen to fifty-five per cent., and especially the same mixtures reinforced with the moderate percentage of crystalline inert pigments referred to above.

Tinted paints possess greater hiding power than white paints; and the above proportions would be somewhat changed for a tinted paint containing any percentage of coloring material. Tinted paints are, moreover, far more serviceable than white paints, as will be shown later.

Mill v. Paddle.—The mixtures under consideration should be ground in linseed oil by the manufacturer, through stone or steel mills, to a very fine condition, as it is only through proper grinding that the pigments can be properly blended. The mixing of paint by hand is, fortunately, to a large extent a thing of the past. The uneven lumping of hand-mixed paints is often the cause of their failure. Such ancient and crude practice should be avoided by every painter, for it is more economical to obtain semi-paste paints, properly ground by machinery, to such a condition that they may be easily broken up and tempered. Such paints may be reduced to the proper consistency with oil and volatile thinner for application to any kind of wood.

In the opinion of the writers, a majority of the paints sold by reputable dealers and made by reputable manufacturers in this country are not only made from the best linseed oil and highest grade pigments obtainable, but are put in a form ready for the painter to thin down with full oil or turpentine reductions, either for priming work or to be used without reductions for finishing coats. The large metropolitan painter who wishes to make his own tints and shades may, however, prefer to have his mixed pigment paint ground by the manufacturer in heavy paste form for certain purposes.

Results of Field Tests.—A careful analysis of the results of field tests which have been carried on in different parts of the country would be far too voluminous for insertion in this bulletin. The official findings of special com-

mittees of inspection have already been published in special reports. Whereas there may still remain ground for some difference of opinion in regard to the interpretation of the results obtained on the various test fences, there can be no doubt that considerable information of the highest value has been yielded both to the producers and consumers of paints. One of the principal results obtained from these tests has lead to the opinion expressed above by the writers, that better results can be obtained by a proper mixture of selected pigments than by the use of any one pigment in linseed oil. This conclusion has also been reached by engineers of the United States Navy, and, as a result, the specifications of the Bureau of Yards and Docks for paints made of straight white lead and oil have recently been changed to call for white lead combined with upward of fifty per cent. of zinc oxide. Many engineers and master painters have interpreted the results of the tests in the same way, and the attention of the authors has been called to a number of opinions which show that the tendency of demand among those who are properly informed is for a high grade combination type of paint rather than for any single pigment paint.

Color.—The selection of the color for a dwelling or other structure is a matter that depends largely upon the good judgment and taste of the owner, combined with the advice of the painter. One point, however, should be impressed upon the mind of both, namely, that practically all shades or tints made upon a good white paint base, through the use of permanent tinting colors, will better withstand exposure to the atmosphere than the white base used alone. Owing to the cheerful effect produced by the use of white paints on dwellings, a very large quantity of white will continue to be used. If these white paints are designed in line with the suggestions brought out above—that is to say, if the white lead bases are properly reinforced with zinc oxide and other pigmentary materials—better results will undoubtedly be obtained, as far as appearance and durability is concerned, than if white lead had been used alone. The consumer should remember, however, that more durable results will be obtained by the use of tinted paints.

Reductions and Thinners.—Turpentine, with its sweet odor, high solvent action, and wonderful oxidizing value, has always taken first place amont the volatile liquids used for thinning paints. Wood turpentines, produced from the steam distillation of fine-cut fat pinewood or from the destructive distillation of stumpage and sawdust, have been refined in some cases, by elimination of odor and toxic effects, to such purity that they are equally as good as the purest grades of gum turpentine, and their use is bound to increase in the paint industry.

The painter and manufacturer have come to understand that certain grades of asphaltum and paraffine distillates are equally as satisfactory as turpentine for use in paints for exterior purposes. Those volatile oils which are distilled from crude oil with either a paraffine or asphaltum base and possessed of boiling point, color and evaporative value approximating similar constants of turpentine, are excellently suited to partly, and in some cases wholly, replace turpentine in exterior paints. A little additional dryer added to paints thinned with these materials will cause oxidation to take place in the proper time.

Prominent master painters* have shown that benzol, a product obtained from the distillation of coal tar, differing from benzine, a product obtained from the distillation of petroleum, is a valuable thinner to use in the reduction of paints for the priming of resinous lumber such as cypress and yellow pitch pine. The penetrating and solvent value of benzol is high, and it often furnishes a unison between paint and wood that is a prime foundation to subsequent coatings, preventing the usual scaling and sap exudations which often appear on a painted surface. Because of the great solvent action of benzol, however, this material should never be used in the second and third coatings. These facts will doubtless interest the southern painter, who has so much wood of a refractory nature to paint.

Oils.—The increasing cost of linseed oil has raised the interesting question as to whether or not it is a good practice to use an admixture of other oils in connection with it, in high-grade paint coatings. Strong differences of opinion will probably be found in regard to this question, and undoubtedly further investigation work is necessary in order to decide it. A number of different oils have been proposed for the purpose, of which, perhaps, soya-bean is one which has been most prominently discussed. No definite formulas, however, should be recommended until the results of investigations which are now being carried on are in hand. A systematic series of test panels is now being erected in Washington, D.C., on the grounds of the Institute of Industrial Research, which are designed to gather data covering just this point.

The flax crop conditions have been most discouraging during the past two years, and the natural shortage of seed has caused a rise in the price of linseed oil, which has necessitated a rise in the price of paint. The added protection to be secured, however, through the frequent application of paint for outweighs any increased cost which has been caused by the rise in price of the raw commodities entering into the composition of paint.

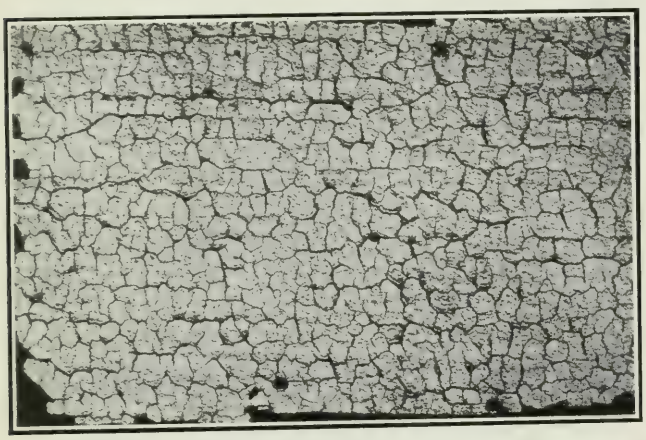
Paints for Interior of Dwellings and Buildings.—The proper decoration of the interior of dwellings and public buildings has become of even greater importance than the protection and decoration of exteriors. There is, moreover, an increased demand for harmonious effects and the production of more sanitary conditions than have prevailed in the past. Up until a few years ago, a great variety of wall papers of more or less pleasing appearance were almost exclusively used for the decoration of walls in the interior of buildings, and their application was commonly considered the most effective means of wall decoration. There seems to be no question, however, that the use of wall paper is steadily decreasing, and that the art of interior decoration is undergoing a transition to the almost universal use of paint.

Modern process demands the maintenance of sanitary conditions for the benefit of the public welfare, and there is no doubt that from the standpoint of sanitation and hygiene, properly painted wall surfaces are far superior to papered walls. There is an abundance of evidence which shows that dust germs may easily be harbored, and thus disease transmitted from wall paper. In the tenement houses which are common to the larger cities, and to a lesser extent in the dwellings found in smaller communities, where tenants are more or less transient, the continued maintenance of sanitary conditions presents a difficult problem. Infectious and epidemic illnesses generally leave behind bacilli of different types, which may find a culture medium in the fibrous and porous surfaces presented by wall paper, backed up as they invariably must be by starch, casein or other organic pastes. Occasionally the restriction of local boards of health provide in such events for proper fumigation, but too often no precautions are taken to destroy the disease germs which are caught in the dust which collects on wall paper. As a rule, both tenant and landlord are obvious to all conditions which cannot be readily seen or detected.

* Dewar, Titzel, et al.

Burning sulphur, one of the most effective means of fumigation, will generally cause bleaching and consequent fading of the delicate colors used in printing the designs upon wall paper. Washing of the paper with antiseptic solutions will destroy its adhesiveness to the plaster and often cause bulging and general destruction.

Hospital Practice.—In hospitals, where it is necessary to maintain sanitary conditions, the walls are invariably painted, and requirements should demand the use of paints which can be washed frequently, so that there will be no possibility of uncleanliness. Inquiry made of a prominent surgeon connected with one of the large metropolitan hospitals substantiated the writer's findings regarding the greater sanitary value of wall paints; and brought forth the information that in hospitals under construction provision had been made for the finishing of walls so that a hard, non-absorbent and washable surface might be obtained. The same authority stated that the common practice, in apartments and tenements, of covering the old wall paper over with a layer of new, each time a tenant moved in, should be condemned, and that from a hygienic standpoint the use of sanitary wall paints should be advocated in all dwellings as well as public buildings.



"Alligatoring."—Type of Decay Exhibited by Improperly Made Paint.

If such conditions are maintained in hospitals, where special attention is paid to sanitation, it would appear that similar precautions should be equally as necessary in public buildings and in dwellings—wherever, in fact, people congregate to live.

Sanitary Wall Paints.—Cold water paints or kalsomines should not be used, as they often contain glue, casein, dextrine and other binders which are easily destroyed. Oil paints which are thinned with turpentine and other volatile spirits are the only real sanitary paints to use. There have recently apeared in trade a number of wall paints composed of non-poisonous pigments ground in paint vehicles having valuable waterproofing and binding properties, and of a nature to produce the flat or semi-flat finish that has become so popular. Such paints produce a sanitary, waterproof surface, which permits of frequent washing. By their use it is possible to secure a more permanent and wider range of tints than can be obtained with wall paper, as they are produced in a myriad of shades, tints and solid colors, from which any desired combination can be selected. On the border or on the body of walls decorated with such paints, attractive stencil designs, which bring out in relief the color combinations, may be applied.

For the decoration of chambers and living rooms, delicate French grays, light buffs, cream tints and ivory whites may be used, while in the library and other rooms richer and more solid colors, such as greens, reds and blues, may be harmoniously combined.

Defects of Wall Paper.—It recently occurred to the writer to investigate the conditions which obtain in many apartment houses in the larger cities. Inspection of a number of such places, in which wall paper had been exclusively used on the walls, showed generally bad conditions; bulging of the surfaces, caused by dampness in the walls, which had loosened up the binder, as well as peeling and dropping of the paper from the ceilings, were frequently observed. In many cases a shabby appearance was shown, accompanied by an odor which suggested decomposition of the paste binder used on the paper. The writer was impressed with the fact that such conditions could easily be avoided by the very simple expedient of using properly manufactured wall paints, which are so easily made dustproof and waterproof.

Samples of wall paper, which had been applied to plastered walls for a year or more, were obtained and examination under the microscope showed a most uncleanly surface. Cultures were made of these samples, and bacilli of different types were developed in the culture medium in a short time.

Experimental Evidence.—That the above conditions could not have existed had proper wall paints been used, seemed doubtless, and suggested a carefully conducted experiment to prove the relative sanitary values of wall paper and wall paints. A large sheet of fibreboard, such as is occasionally used to replace plastered walls, was painted on one side with a high-grade wall paint, three-coat work. A similar sheet was papered on one side with a clean, new wall paper. These test panels were placed where unsanitary conditions, such as dampness, foul odors, and a scarcity of air, were present. After a short period of exposure, the panels were taken to the bacteriological laboratory and a small section of the painted surface, about two inches square, as well as a small section of the papered surface of similar side, were removed and used for making cultures. In each case the surface of the section under test was washed with 100 cubic centimeter of distilled, sterilized water. The washings, which dripped from the surface, were collected in a graduated flask. One cubic centimeter of the washings was used in each case, admixed with bouillon and again with agar-agar. The enormous development of bacteria in the bouillon, treated with the washings from the wall papered surface, was sufficient evidence to convince one of the greater sanitary value of the wall paint, the washings from which gave a culture practically free from bacteria. The colonies of bacteria shown in the petri-dish made of the washings from wall paper further supports these findings. It will be noticed that the tests made from the washings of the wall paint show practical absence of bacteria, and was clear, as was the bouillon-solution test of paint. The washings from the wall paper showed active development of bacteria, both in the bouillon and agar tests.

From the Conservation Standpoint.—It would be of interest to sum up in figures the acreage and cordage of wood that annually is transformed into pulp for the manufacture of wall paper. Unfortunately there are no available statistics on this subject. It is clear, however, that from the standpoint of conservation the use of wall paints should take precedence over the use of wall paper.

Paints for the Prevention of Corrosion of Iron.—The protection of structural steel is a subject that most painters have in the past considered of minor importance, any paint that would properly hide the surface of the metal being accepted without much question. The demand, however, for structural steel for office buildings, factories, steel cars, railroad equipment, etc., has doubled the output of structural

paints, and created a demand for painters having a knowledge of the proper materials to use in the painting of steel, so that its life may be preserved and its strength maintained. Such knowledge is as important to the painter as a knowledge of how to properly select materials for the painting of wood, and how to temper these materials to suit the various conditions met with.

Every one is familiar with the appearance of rust, but few actually understand what causes rust. No attempt will be made here to present even an outline of the many theories advanced to explain the phenomenon of the rusting of iron, for the subject is as diverse as it is interesting. A brief résumé, however, will be given of the now generally accepted theory that explains the subject. This theory is called the electrolytic theory.

"Auto-electrolysis" is the term used to define the peculiar tendency of iron to be transformed from a metal possessing a hard lustrous surface, high tensile strength, and other useful properties, to a crumbling oxide that falls to the ground and again becomes part of the earth from which it was originally taken by man.

This "going back to nature" is more readily accompanied by most of the steel produced to-day than by the old hand-made irons produced many years ago. It seems to be a curious fact that the more quickly a product or an article is fashioned by man, the more quickly it tends to return again to its original oxidized condition. Some manufacturers of steel, however, through an understanding of the causes of rust, have progressed in the manufacture of slow-rusting materials, either by the elimination or by the proper distribution of impurities.

When iron is brought into contact with moisture, currents of electricity flow over the surface of the iron between the points that are relatively pure and points that contain impurities. These currents stimulate the natural tendency of the iron to go into solution, and the solution proceeds with vigor at the positive points. The air which the water contains oxidizes the iron which has gone into solution, and precipitates the brown iron rust with which you are all so familiar. Thus water, which acts as an acid, and air, which acts as an oxidizer, have combined together to accomplish the downfall of the metal. It is obvious that if means could be devised to stop the solution pressure of iron, and make it resistant to the flow of surface electric currents, rust could be prevented. Materials which prevent the rusting of iron have been called by Dr. Cushman, who first advanced these explanations. rust inhibitors, or materials which inhibit rust. The paint maker, realizing the importance of these rust inhibitors, is incorporating them into paints designed for the protection of iron and steel, and the success which paints of this type have met with from a practical standpoint is a justification of what was first called the electrolytic theory which suggested their use. The laws of electrolytic corrosion would be a better way of stating what have become facts, and these laws are a direct result of the early pioneer researches of Dr. Cushman, who was formerly for many years in the Government service, but who is now the director of the Institute of Industrial Research in Washington. By placing small, brightly-polished steel plates into a mush of paint pigment and water, a determination may be made of the pigment's effect upon the metal. Some pigments under such conditions cause rapid corrosion of the steel plates. Such pigments are stimulators of corrosion on account of acid impurities which they contain, or because of their effect in stimulating galvanic currents. Many carbonaceous pigments are of this type. Other pigments have the effect of keeping bright the steel plates and preventing rust. Such pigments are of the inhibitive type, and their action is to check or retard the solution pressure of the iron.

Results obtained in many laboratory tests suggested a practical exposure test, and a series of three hundred large steel plates were exposed by the writer, acting under the American Society for Testing Materials, at Atlantic City, where the action of the salt air is severe on both paint and metal. In these tests separate plates were painted with nearly all the useful paint pigments, ground in a vehicle of raw and boiled linseed oil. Later in the test it was found that many pigments of the carbonaceous type, as well as those which contained acid impurities, were showing bad results. It was also found that pigments of the inhibitive type, such as chromates of lead, zinc, barium, etc., acted in an almost miraculous way, transforming the surface of the metal upon which they were applied into a practically uncorrodible condition.

The excessive chalking which took place on the corroded white lead coatings began to disappear at the end of a year, being washed away by the rains and carried away by the winds, so that there was left upon the surface thin coatings of pigments, insufficient to give good protection. Had this white lead been reinforced with sufficient zinc oxide to prevent chalking, much better results would no doubt have been obtained.

The deep cracking of the zinc oxide indicated that such a pigment required a large quantity of oil in order to satisfy its brittle nature and prevent such effects. White paints containing zinc oxide and zinc oxide products were in excellent condition, and they confirm preliminary tests which showed zinc oxide to be one of the most valuable pigments for protecting iron.

Although sublimed white and blue leads chalked very heavily, the chalked pigment seemed to be tenacious, and adhered to the plate, presenting a good surface with absence of rust. Both these pigments gave very good protection to steel. When admixed in the right proportion with certain other pigments, they give still better results.

Lithopone was early destroyed, as is usual with the pigment when used alone on exterior surfaces. It became rough and discolored, presenting a very blotchy appearance. Red lead and orange mineral both afforded excellent protection to the plates upon which they were applied. They became covered, however, after exposure with a white coating of carbonate of lead, which was due to the action of the carbonic acid of the atmosphere on the red lead, which is an oxide of lead, and susceptible to chemical action.

The iron oxide gave fair service indeed. In one case, however, there were several eruptions, indicating slight corrosion beneath the surface of the paint. One iron oxide which did wonderfully well was the black oxide of iron which not only possesses great tinting value, but up to the present time has had a high protective value. The graphite was very deeply pitted at certain spots, indicating that galvanic currents had been set up, causing stimulating effects. Barytes and blanc fixe, when used alone, gave very poor service, showing scaling, chalking disintegration, and rust soon after the test was started. Barytes, combined with some other pigments, however, presented a very good surface. Under the paint film of gypsum rust soon appeared, and although the film itself remained fairly intact, rusting progressed throughout the test, indicating that gypsum films were very poor excluders of moisture. Coal-tar paints failed in the test, and this was due, no doubt, to the strong action of the sun, which early destroys such products. China clay and asbestine gave excellent service for eighteen months. After that time, however, indications of corrosion were shown, and the apparent breakdown of the film was predicted. These pigments, however, combined with other pigments, have given excellent service.

American vermilion, zinc chromate, zinc-and-barium chromate, chrome green, Prussian blue, and zinc-and-lead chromate gave most wonderful service, presenting an appearance within two years that was almost identical with their appearance at the start of the test. These pigments with red lead, zinc oxide, litharge, sublimed leads, combinations of lead and zinc, willow charcoal, neutral oxide of iron and the inert pigments, will allow the design of paints of nearly any color. From their admixture properly adjusted with a good paint vehicle, and tested by the expert, will come the final solution of the problem that has bothered painters and engineers for so many years. The vehicle for such paints should be made of linseed oil with or without the addition of treated linoleates, tungates, and fossil gums, until such a time as a modern research has found a vehicle more suitable.

THE HEYWOOD SEWAGE PURIFICATION AND REFUSE DESTRUCTOR WORKS.*

By R. J. McKenn, Manager.

The refuse destructor works were opened on June 15th, 1903, and have since been regularly working. The plant consists of two front-feed units of the Meldrum patent "Simplex" regenerative type, hand fed, and having an effective grate area of 50 square feet, and works in conjunction with a Lancashire boiler, 20 ft. long by 7 ft. diameter, with a total heating surface of 570 square feet, working at a pressure of 150 lb. per square inch. The "Simplex" grate consists in having the furnace chamber common to the number of grates. This arrangement of continuous grate ensures the maintenance of an evenly high temperature, and allows of one section being cleaned and charged while the other is in an incandescent state, and as the gases commingle in the furnace, and again in the combustion chamber, complete immunity from dust or smell from gases leaving the chimney is ensured. The temperature in the combustion chamber varies from 1,700 deg. Fahr. to 2,000 deg. Fahr. The gases of combustion pass from the furnace into the combustion chamber, through the boiler and its settings in the usual manner, thence through the regenerator to the chimney flue. The regenerator, or air heater, consists of a number of cast iron tubes, through which the gases of combustion pass to the main flue. The air for combustion drawn by the steam jet blowers, which produces the forced draught, circulates round these tubes, and becomes heated in its passage to a temperature of from 250 deg. Fahr. to 350 deg. Fahr., this temperature varying with the quantity and quality of the refuse, as also the size of the boiler. The refuse for consumption in the destructors is obtained from dry ashpits and a good number of privy middens. That from the latter often contains 65 per cent. of moisture, and is of low calorific value. The average amount of water evaporated per pound of refuse is 0.62 lb. The engine-room contains a non-condensing engine, 8 in. diameter cylinder by 14 in. stroke, running at 160 revolutions per minute. This engine drives a 7 ft. diameter mortar mill, and a compound air compressor 8 in. and 6 in. diameter cylinders by 12 in. stroke, with a working pressure of 100 lb. per square inch, also a small inverted direct-coupled engine and dynamo, which gives 20 ampères at 200 volts. The current generated is used for lighting the works.

Sewage Purification Works.—It is now approaching eighteen years since the construction of the Heywood Sewage Works was commenced under the present engineer, Mr. Jas. Diggle, Assoc. M. Inst. C.E., F.G.S., of the firm of Messrs. Jas. Diggle and Son, of Westminster and Heywood. The actual commencement of the scheme was made on August 13th, 1894, but after the work of construction had proceeded some time a most unfortunate discovery was made. It was found that a worked-out coal mine existed practically over the whole site. This caused the committee and engineer considerable anxiety; and instead of the works being built with the usual foundations, it became necessary to excavate to a great depth and fill in with concrete. The foundations vary in depth from a few feet to 56 feet. This, together with pumping the water out of the old mine, added enormously to the cost of the works.

Heywood has a population of 27,000, and the rateable value is £121,700. The sewage treated at the works consists of, besides domestic sewage, manufacturing waste. It may be stated that the council adopt the policy of allowing manufacturers to run their waste into the sewers after treatment. The manufacturing waste consists of liquids from tanneries, flannel scouring, dye works, breweries, and paper stainers. The dry-weather flow of sewage is 850,000 gallons, and the major portion gravitates to the works, and enters by an egg-shaped culvert 4 ft. 6 in. on the major by 3 ft. on the minor axis. Passing through the primary screen, the screening bars of which are 2 in. mesh, the sewage is conveyed to the works by means of a cost iron pipe, 36 in. diameter, 300 yards long, and discharges from an inverted bell-mouth pipe. Part of the sewage is diverted on to a high breast water wheel 14 ft. diameter by 3 ft. wide. The energy generated by the water wheel is utilized for driving the secondary screens, which are of ⅜ in. mesh. A further portion of the sewage is diverted into an Adams lift, where energy is generated free of cost (with the exception of attention for cleaning), for lifting a maximum of 108,000 gallons of sewage per twenty-four hours from Hooley Bridge, which is a low-lying district. This low-level sewage enters the forcing cylinders through retentive valves, which prevent its return when the air pressure is applied. When a forcing cylinder has filled, the supply of high-level sewage used for energy is automatically turned on through the syphonic feed into the flush tanks placed overhead in the air chamber. Each flush tank when full automatically discharges its contents through the deep trap syphon and fall pipe into the air cylinder immediately below, to which it is connected. The air contained in each of these air cylinders is thus expelled as required, and by means of the air pipes is brought to exert its pressure on the low-level sewage contained in the forcing cylinder to which it is connected. The low-level sewage is thus forced automatically to the required level. The air cylinder is now full of high-level sewage, but is at once emptied by the simple syphon attached, and, so after being utilized for work, passes by gravitation to the disposal works. Thus the low-level sewage is raised automatically entirely without cost for energy, and with a minimum of oversight.

After the sewage has performed these functions it is again united, and passes alongside the overflow weir, which is set up to pass the sewage, in excess of three times and up to six times the dry-weather flow, on to the storm filters, which have an area of 6,200 square yards. The sewage from one to three times the dry-weather flow is then charged with alumino-ferric, and passes through the baffle channels and on to the precipitation tanks. There are six of these, with a total capacity of 710,000 gallons, and they are worked on the continuous system.

* Paper read before the Institution of Municipal Engineers at Heywood, Manchester, England.

When the works were originally constructed, contact filters were laid down. There were twelve in number, with a total area of 1,325 square yards. These gave excellent results, but they were not sufficient to deal with the whole volume of sewage; consequently it was necessary to construct additional beds. There are twelve beds, constructed on the percolating system, each 60 ft. diameter by 8 ft. deep, having a total area of 3,720 square yards. The sewage is distributed on to the beds by means of the "Simplex" distributing apparatus. This apparatus can be set to feed the beds in rotation for any desired period of time. When No. 1 bed has had a ten minutes' supply the distributor automatically diverts the flow to No. 2 bed for ten minutes, and so on throughout the series. Should the flow of sewage increase through rain or any other cause, one bed is not sufficient to deal with the flow, and the distributor automatically brings additional beds into action in ratio to the flow, and as the flow decreases the beds go out of action in ratio to the flow. The cycle of changing is going on continuously. Provision is also made which enables any bed in the series to be put out of action by simply placing a disc on the distributor, for no matter how well a sewage works may be managed there are times when the beds become sick and require a rest.

The bacteria beds are constructed on a concrete base, cone-shaped—that is, the centre of the beds is higher than the outer circumference. This allows the effluent to run to the effluent channels, which are constructed round the outside of the beds. The filtering media is laid on floors constructed with Ames-Crosta's floor tiles, which give a free access of air under the beds and allows a free passage for the humus matter to escape. The outside walls are constructed of pigeon-hole brickwork, 14 in. thick for 4 ft. high and 9 in. thick for the remaining 4 ft., and eight buttresses are constructed to each bed. As the effluent discharges from the beds it is collected by two main carriers, which convey it to the humus tanks. These tanks, two in number, are each 130 ft. long by 24 ft. wide, and vary in depth from 18 in. at the inlet to 2 ft. 6 in. at the outlet sills. These tanks are cleaned out every week. A Shone's ejector of 50 gallons capacity is fixed for raising the humus sludge from the humus tanks up to the precipitating tanks. This ejector is worked by compressed air, and works against a head of 24.62 ft., exclusive of pipe friction.

The sludge from the precipitation tanks gravitates to the sludge well, which is situate under the engine-room. A cast iron box is fixed in this well, into which the sludge falls, and when a charge is required compressed air is turned on and the contents of the box ejected up and into the sludge mixer. There are three sludge presses, each fitted with twenty-eight plates. The press liquor runs from the presses into a steel boiler-shaped receiver, and when the rams have discharged the sludge into the presses, the exhaust air is conveyed to the steel receiver; the whole of the press liquor being thus raised to the precipitation tanks. The energy required for driving the agitating gear in the mixer, also the hauling gear for bringing the pressed cake to the top road, is obtained from a 6 in. diameter cylinder engine by 12 in. stroke, which is driven by compressed air.

Automatic samples are fixed on the crude sewage inlet to the Adams lift tanks, the effluent from the precipitation tanks and the final effluent. This is an advantage, and obviates the necessity of workmen taking samples every hour. The appliances are simple and work continuously, thus ensuing an average sample being obtained extending over the twenty-four hours.

OZONE PLANT OF THE CENTRAL LONDON RAILWAY.

The management of the above underground railway has recently attempted to improve the condition of the air in their runways by the addition of an ozone plant manufactured by the Ozonair Company. As an experiment, the railway officials installed a trial outfit in the Bank Street station about two years ago and the results obtained justified the extension of the system to other stations along the line.

The supply of ozone is dependent upon the well-known principle of the silent electrical discharge on the oxygen of the air. At each station the equipment includes a rotary converter, a transformer and a motor-driven Sirocco fan; accessory to these are air washers and filtering screens. This apparatus is fixed at surface level and usually in the booking hall whence the upper air is drawn into the particular local system. Reference to Fig. 1 will explain the details of the arrangements employed. In each plant air is drawn from outside through a fine copper mesh filter screen, over the surface of which a thin film of water continually flows. This washes the incoming air, removing dirt and smuts, and deleterious gases.

The air is drawn into a Sirocco ventilating fan driven by a motor of 7 h.p., where it meets a comparatively strong ozone mixture delivered from an adjacent ozone generator, and is discharged in its ozonized and purified condition through trunking to the station platforms down below.

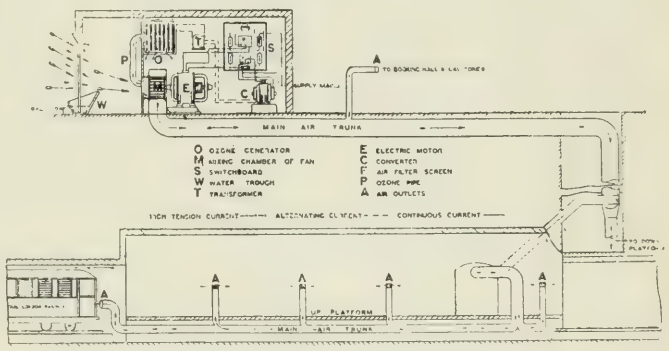


Fig. 1.—General Diagram of Ozonizer Plant at Tube Stations, Showing Details of Equipment and Delivery Ducts.

The ozone apparatus consists of 10 mica and gauze generating units, the gauze sheets being supplied with current at 5,000-6,000 volts pressure from the secondary of a small transformer, the primary of which is connected to the 380-volt a.c. side of a small rotary converter, running on a 550-volt d.c. circuit. A suitable switchboard is provided for controlling the fan motor and converter, and the whole apparatus is exceedingly compact and controllable as to the amount of air delivered and strength of the added ozone mixture, according to temperature or barometric requirements; moreover, the working is practically automatic.

In each station a small proportion of the clean treated air is supplied to the ticket office, lavatories, etc., on the surface; the remainder passes down a main trunk to a distributing duct under each platform, rising branches delivering air at a height of about 7 feet above platform level.

The large ducts under the platforms are continued about 40 feet along the tunnels in the direction in which the trains leave, with a view to the trains themselves assisting in the circulation of the treated air through the tunnels. About a third of the total air delivered is distributed over the platforms, the remainder being delivered into the tunnels.

A DOSING APPARATUS FOR WATER SUPPLIES.

An apparatus for introducing a chemical reagent into water flowing through a pipe under pressure is described in a recent issue of The Engineer (March 29, 1912).

In this device, shown diagrammatically in the figure herewith, the pressures in the mouth and throat of the Venturi tube at A are communicated to the two vertical tanks B and C respectively, so that the height of liquid in these two tanks varies with the Venturi pressures. In these tanks are suspended the hollow cast-iron cylinders G and F, hung from hooks in the end of the balance beam with fulcrum at E. These cylinders are so proportioned that their specific gravity is somewhat greater than unity, so that they are submerged in the liquid in the tank.

With no water flowing through the main the pressure at the mouth and throat of the Venturi tube is the same and consequently the liquid in the two tanks B and C stands at the same height, say at H_1 in the figure. Under these conditions the cylinders G and F will hang at the same height. The lengths of the rods connecting the cylinders to the balance beam are so proportioned that with the cylinders at the same

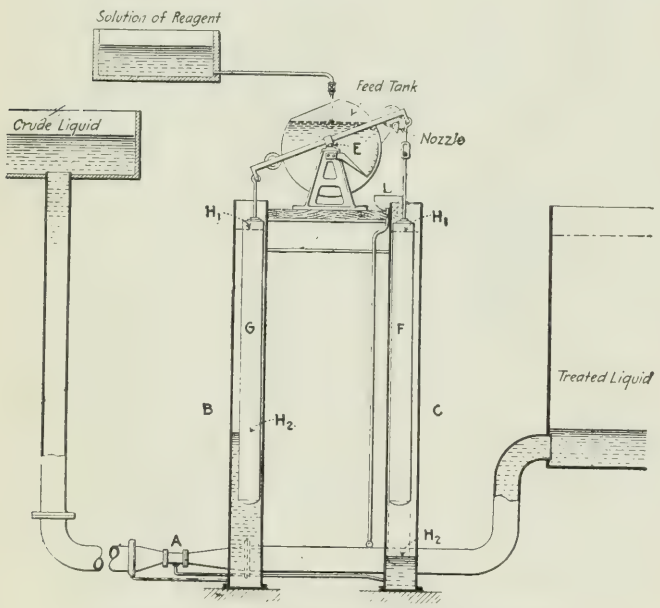


Diagram of the Tiltometer Dosing Apparatus.

height the feed tank, which it attached to the balance beam, will be in such a position that the level of the solution in the feed tank will be just below the discharge nozzle. The level of the solution in the feed tank is kept constant by a float valve. The position of the tank can be adjusted by means of the turnbuckle in the rod at the right end of the beam in the figure.

When the water is started flowing through the main, the water level in both tanks will fall, say to the levels of H_2 in the figure, with the level in the left-hand tank, connected to the mouth of the Venturi tube, higher than that in the right-hand tank, connected to the throat of the tube. As a result the equilibrium of the cylinders and balance beam will be disturbed and the right-hand cylinder F will descend sufficiently to equalize the immersion of the two cylinders. This motion of the cylinders causes the balance beam and consequently the feed tank to be tipped down at the right, so that some of the solution in the tank flows out through the nozzle into the cup L and then through the feed pipe into the main.

The amount by which the feed tank is tipped and consequently the head producing the flow of solution through the feed nozzle is proportional to the movement of the cylinders G and F and therefore to the difference in head at the mouth and throat of the Venturi tube. Hence the quantity of solution added is at all times proportional approximately to the amount of water passing through the main. The orifice of the feed nozzle can be adjusted to give the desired number of grains of solution per gallon of water treated.

It is claimed by the manufacturer, George Kent, Ltd., of High Holborn, W.C., London, England, that the variation in the proportion of solution added does not exceed 1⅔% from the mean under the most extreme conditions of working. In support of this claim, the following results are given of tests made upon one of these devices:

Water.	Solution. gals. per hr.	Per cent.
640	19.8	3.09
1720	52.2	3.04
1820	57.2	3.14
2390	73.7	3.08

The device has been patented jointly by the Hon. R. C. Parsons and Mr. Walter G. Kent. It is manufactured under the trade name of "tiltometer."

HEAVY-OIL ENGINES.

The first of a series of four lectures under the Howard Bequest, on the subject of "Heavy-Oil Engines," was delivered by Captain H. R. Sankey before the Royal Society of Arts on the 29th ult. Captain Sankey began by pointing out that some twenty years ago there was only one form of oil-engine of which the Hornsby-Akroyd and Priestman could be taken as types. These engines required external heat at starting for the evaporation of their fuel, and worked on paraffin. In 1890 Daimler invented the petrol-engine which worked with petrol having a specific gravity of about 0.68, and which required no external heat for the evaporation of its fuel, while in 1897 Diesel introduced his engine, which worked with heavy oil, and required no external heat, as the fuel was mechanically pulverized instead of being evaporated.

Oil-engines at the present time were, Captain Sankey said usually considered as divisibe into two casses: the light-oil engines, which used fuel capable of forming explosive mixtures at ordinary temperatures, and having a specific gravity ranging from 0.68 to 0.72, and heavy-oil engines, which used fuel requiring high temperature or mechanical pulverization, for the formation of explosive mixtures, and which had a specific gravity ranging from 0.8 to 0.9. He proposed in his lectures to confine himself entirely to the heavy-oil class. In the Diesel engine the compression took place entirely on a charge of air, into which the fuel was afterwards injected, so that there was no danger of pre-ignition, and compression pressures up to from 450 to 500 pounds per square inch could be used. It was in its high compression that the great efficiency of the Diesel engine lay. In the semi-Diesel type of engine, in which, after compression of air, the fuel was injected into a hot bulb, there was no danger of pre-ignition, but compressions up to about 200 pounds per square inch were usually found sufficient to ensure ignition.

Captain Sankey, after pointing out that the Diesel engine was the most important of the heavy-oil class, and stating that he proposed to devote the greater part of his four lectures to it, then gave a brief history of its development, beginning with Dr. Diesel's first example of 1897. Incidentally, and in connection with his historical summary,

Captain Sankey suggested that the relative backwardness of this country in the development of the Diesel engine was due to the cheapness of our coal. He thought, however, that great progress was likely to take place in the future, particularly in connection with marine work.

Captain Sankey then dealt in a comparatively elementary way with some theoretical aspects of the Diesel engine. He drew a comparison between water-wheels, or water-turbines, and heat engines, pointing out that while the possible work which might be obtained from the former depended only on the height of the head of water, the possible work which might be obtained from the latter did not depend merely on the head of heat available—i.e., on the temperature—since the question of the specific heat of the working substance had to be taken into account. Captain Sankey illustrated this point by means of a heat-chart, and compared the efficiency of the Diesel cycle with the Carnot cycle. He pointed out that the Carnot cycle involved both admission at constant temperature and exhaust at constant temperature, and stated that Dr. Diesel's original idea had been to construct an engine working on the Carnot cycle and using pulverized coal as a fuel. In the Diesel engine admission took place at constant pressure and exhaust at constant volume, as compared with the gas-engine and petrol-engine, in which admission took place at constant volume. This difference gave the Diesel engine an advantage, since there was a greater difference between the upper portions of the actual and theoretical diagrams in the two cases. The economy of the Diesel engine was also largely accounted for by the high compressions, up to from 450 pounds to 500 pounds per square inch, which could be used. These figures compared with from 130 pounds to 150 pounds per square inch for gas-engines, and 70 pounds to 80 pounds per square inch for petrol-engines. In the latter cases the figure had to be kept low for fear of pre-ignition.

Captain Sankey then referred to the temperature reached in the cylinder of a Diesel engine. This was usually stated to be about 1,000 deg. Fahr., but he thought the figure too low. He did not know that the temperature had ever been directly measured, but the formula for the temperature of compression of air showed that the temperature should be about 1,500 deg. Fahr. No doubt it would be less than this in practice, owing to conduction loss, but he suggested that it was usually nearer 1,200 deg. or 1,300 deg. than 1,000 deg. He thought the temperature of 1,000 deg., which was so frequently given, might be explained on the assumption that, in calculating the matter, the lower temperature of the air had been taken as that of the outer atmosphere, but, arguing from gas-engine practice, it was likely that this lower temperature was nearer that of boiling water than of the atmosphere. Captain Sankey then traced through the various operations of the four-stroke cycle and two-stroke cycle of the Diesel engine. He pointed out that with a two-stroke cycle gas-engine there was danger that some of the new working charge might be blown out of the exhaust by the scavenging air, but that in a Diesel engine this could not happen, so that the Diesel might be looked upon as essentially a two-stroke engine. It was usual practice in such engines to admit scavenging air to about 80 per cent. greater amount than the volume of the cylinder. The four-cycle Diesel was more economical than the two-cycle, owing to the slight loss at the toe of the diagram with the latter consequent on the entry of the scavenging air.

INTERMITTENCY IN ELECTRIC TRACTION.

In a paper read before the Society of Engineers of England on "Intermittency: its Effect in Limiting Electric Traction for City and Suburban Passenger Transport," Mr. Wm. Yorath Lewis remarked that intermittency was a characteristic common to all systems of passenger transport in general use, and, while it might not be an objectionable feature in the case of a trunk line railway with long distance trains, its effect upon urban and suburban passenger transport was extremely detrimental. In city, urban, and suburban service the inherent nature of the traffic was that of a continuously flowing stream, which varied considerably in volume at more or less definite periods of each day, maximum density occurring at morning and evening during what were known as the "rush" hours. Usually the flow was along well-defined and regular channels between certain localities, but periodically the traffic stream was diverted, and was often augmented in volume, according to special circumstances. The means for dealing with this human stream should, consequently, partake so far as was practicable, of a continuous as distinguished from an intermittent nature.

Results of Intermittency.—The result of damming a human stream moving at the rate of three miles an hour—if the volume was four abreast six feet apart, and if the period of check was only one minute—consisted in the accumulation of a crowd of 176 people, meaning discomfort and a serious time loss of more than one minute, because of the time required to enable this detachment to board the conveyance, pending the arrival of which it had accumulated. Obviously, if instead of interrupting this human stream, accommodation could be provided with a capacity of, say, about three seats per second passing through the station at a speed sufficiently slow to enable the passengers to step on or off the cars, all delay and congestion would be eliminated. There would be neither the need of a station platform, nor of trains long and large enough to accommodate the assemblage. The present method of dealing with the situation consisted in providing a distinctly intermittent service of trains of limited capacity, run at sufficiently short intervals to ensure the passing of, say, 10,560 seats per hour through the stations. This involved, with 50-seat cars and, say, six-car trains, 35 trains per hour. The Metropolitan District Railway now ran over a section of its lines during the rush hours 40 trains an hour in each direction. Assuming that these trains were composed of six 50-seat cars, their capacity was 12,000 seats per hour. The length of the train was 300 feet, necessitating platforms about 400 feet long. The corresponding time interval between the trains was 90 seconds. The schedule speed was about 15 to 16 m.p.h., and the stations averaged half a mile apart, whilst the average stop at each station was about 20 seconds. As the trains were made up of six 50-foot cars, the aggregate length of train passing hourly through a station amounted to 12,000 feet, or 2.28 miles.

Defects of Present Methods.—The intermittent character of the train-system service was the factor which limited the schedule speed, and consequently the capacity of the line. The limitation of the speed necessitated a larger amount of rolling stock than would be requisite for the same capacity, were it possible to maintain higher schedule speeds. It would manifestly be impracticable and commercially impossible to negotiate such an intensity of service as that of the present underground railways of London, if the stations were to be located at an average distance of only one-quarter mile apart; although, from the viewpoint of traffic and public convenience, stations at these shorter intervals were highly desirable in the case of city and urban routes. Here again the intermittent characteristic proved

to be the bugbear of the electric train system, but still further detrimental effects might be indicated. The maintenance of an intense service (say, 12,000 seats an hour in each direction) involved the problem of starting a heavy mass in the nature of a long train, accelerating this mass to a high speed and then retarding it to rest forty times an hour. With the electric train system this was rendered possible only by providing equipment of a very costly and complicated nature, which involved much skilled attention and a considerable element of human labor for its operation and control. Furthermore, a system involving the transportation of passengers in crowds instead of in streams required not only long, but also very bulky trains, which could be accommodated only in relatively spacious tunnels and at long station platforms. The stresses due to the severity of the service and the weight of the electric apparatus and accessories necessarily carried on the train were so great that the aggregate weight of the rolling stock rarely averaged less than 1,000 pounds per seat, and for more severe services it was much higher. Consequently the permanent way had to be of a substantial nature, and such locations must, notwithstanding the expense, be acquired for the railway, as to eliminate all possibility that neighboring property should be affected by the vibration resulting from the periodic passing of heavy rolling loads.

Conclusion.—The author then discussed acceleration, brake losses, energy consumption, and fixed charges, and finally submitted that in respect of the electric train system, the fundamental cause of its inherent limitations, its excessively high initial and operating costs, and its consequent inability to meet adequately the requirements of the dense traffic usual in all large cities, was its characteristic "intermittency." He urged that in view of the future, which undoubtedly demanded better and cheaper transit facilities in the interest of the community, recourse must be made to the continuous plan because, as he had endeavored to show in a paper read before the Royal Society of Arts on "Continuous Service Passenger Transportation in Relation to the London Traffic Problems," the difficulties which attended the present cumbersome method did not exist in that method, and consequently the prospects of superior achievements were relatively much brighter. He mentioned that it is proposed to put down a full-size railway on the Adkins-Lewis system of about a quarter of a mile in length on the Aldwych island site in order to enable the public to ascertain whether they could mount and dismount the cars when moving at a constant speed of two or three miles an hour. It is considered that, although the system has been demonstrated successfully by the Ipswich experimental plant, the next step in its development must be of the nature of a public trial.

HYDRO-ELECTRIC DEVELOPMENT AT PRINCE ALBERT.

Some time ago we noted that the city of Prince Albert intended to instal a municipal hydro-electric plant at Lacolle Falls on the North Saskatchewan River. The work is now under construction. The completed plant will cost in the neighborhood of a million dollars and will be completed in less than two years. The municipality of Prince Albert are financing the undertaking and Messrs. C. H. and P. H. Mitchell, Toronto, are the engineers. The development includes headworks, dam, navigation lock, power canal, intake works and power house. The contract for the headworks has been let to the Ambursen Hydraulic Construction Company, of Montreal, for $578,000. This contract includes the dam, a navigation lock 40 x 150 feet long and 6 feet deep, and the intake works. The power canal leads from the headworks to the power house, half a mile below the dam, and the excavation will be mainly in boulder clay. With the water available during minimum flow 12,000 horsepower can be produced, while the head obtained will be 30 feet. The turbines will be of the vertical type and six units will be eventually installed. Two will be placed immediately, of 2,000 k.v.a. capacity. The voltage used on the transmission line to Prince Albert will be 35,000. This will be stepped down to 2,300 volts in the local receiving station.

GRILLAGE FOR I-BEAMS.

The conventional base for columns of buildings is a cast-iron (or, in recent years, cast-steel) shoe, of sufficient size of bottom to suit the permissible loading of the stone or concrete foundation. E. W. Stern, consulting engineer, of New York City, has developed a base of the I-beam grillage type, as an improvement on cast bases, which is described in a recent issue of Engineering News, from which this description is taken. A typical design of his form of base is shown by sketch, Fig. 1, herewith. In a letter Mr. Stern gives the following comparisons:

"1. In comparison with cast-steel bases, the grillage base is both cheaper and more reliable. In my own experience, I have had cast-steel bases develop cracks after having been erected, although they had been carefully annealed and inspected before leaving the shop. These had to be replaced after several stories of steelwork had been erected, which entailed very considerable expense.

"2. In comparison with cast-iron, it is cheaper and very much more reliable. In an experience extending over many

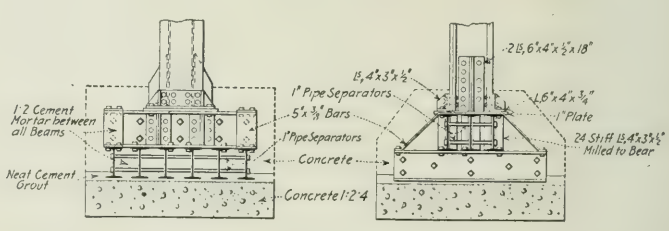


Fig. 1.—Typical I-Beam Base for a Building Column.

years in the use of cast-iron bases, I have known far too many to have developed cracks after they had been erected in the building, often entailing large expense for replacing them. For this reason I have not been using cast-iron bases for about 10 years.

"3. The grillage form of base is easier to set properly being much more readily grouted.

"4. Stresses can be readily calculated (which cannot be said of the usual design of cast base). The conventional method of analysis for shear, crippling and bending is accurate enough or all practical purposes."

The design shown has been used on loads up to 16,000 tons, and by slight modifications it may be used for much larger loads.

Shallow beams with heavy webs are preferred, avoiding the necessity of reinforcing the webs. However, Mr. Stern always uses stiffeners ground to fit, in the upper tier of beams, whether or not the calculations show them to be required.

In building these grillage bases, the beams are bolted up complete in the shop, and each tier of beams is bolted together, ready for erection in one piece. Pipe separators should be used plentifully, and in the top layer they should be spaced not over 6 in. vertically and in. horizontally. After setting, the base is, of course, grouted, all spaces between beams being filled with 1:2 Portland cement mortar.

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BRITISH MANUFACTURERS.

A party of British business men and manufacturers arrive on June 6th at Quebec on a visit of inspection of the Dominion. The party will make an exhaustive tour from coast to coast, visiting all the chief cities and industrial centres. The tour has been organized by the Financial News of London, which of late years has devoted marked attention to Canadian affairs, and under whose auspices the trip will be carried out, with the hearty co-operation and support of the Dominion Government. In speaking of the proposed trip, the Financial News says: "The British Dominion of Canada is clearly intended by Nature to be an industrial, as well as an agricultural, land of the first magnitude. She possesses the raw material of modern industry in an almost boundless degree. Her reserves of timber (the last great stands in the world), with proper care, are practically inexhaustible; iron, copper, and all the metals required in manufactures are present in great abundance; her coal fields are vast, and already are being profitably worked at many points of her wide territory. Natural gas, oil, and other fuels also abound. To crown all, her waterpowers are capable of indefinite expansion at moderate cost—already in her eastern provinces the horse-power developed from water runs well into seven figures. Judged from her infinite capacities in this respect alone, Canada is a potential manufacturing country of the first rank."

This trip should be the means of developing the already cordial spirit existing between the Mother Country and her leading colony. It will give these men, who are the leaders in the financial and manufacturing world, an opportunity for studying at first hand the conditions that exist in the Dominion for the establishment of branch factories, the openings for capital in industrial undertakings, and the possibilities of extending the market for British-made goods. Their reception throughout the country will be most friendly. It is difficult to foresee the far-reaching results which will flow from an intimate inspection of this nature, but it will be certain to develop the trade relations between the two countries by opening up new avenues of commerce and broadening the existing ones.

ROADS.

The question of good roads is at last receiving the attention it deserves. Our neighbors to the south of us are much farther advanced along this line than we are. Necessity has forced them to take action, and as a result, in the last few years a great deal of road construction has been done. In New York State practically all the towns and cities are united by first-class highways, and in nearly all cases these roads are built for the particular service and traffic for which they are used. In the last two years a great impetus has been given to good road construction in Canada. We believe, however, that too little attention is being paid to the choice of roadway for the particular traffic expected for it. This is a very important requisite; in fact, we would say the most important consideration at the present time in the design of a highway. Maintenance is dependent to a large extent on the kind of roadway and

the class of traffic, and, unless these two things are co-related, the good roads question is liable to receive a serious setback. When the York County Highway Commission of Ontario first outlined their programme, it was expected that the better class of roads, or that class which may be termed permanent, would not be necessary. However, after consideration, the Commission has decided that on many of the main arteries of traffic leading into the city of Toronto it would be advisable to put down a more permanent road than can be secured with water-bound macadam. There is little question that these main thoroughfares will carry an immense amount of traffic over what they are at present handling, and this will mean, if the poorer type of road is used, that it will quickly disintegrate and break down under the heavy travel. The Commission has approached the city and the Provincial Government to secure funds in order that this new programme may be carried out. It is to be sincerely hoped that funds will be placed at their disposal for this work, for nothing but failure can result in the use of a type of road which is not adapted for the traffic conditions.

FLAMELESS GAS HEAT.

The supremacy of gas fuel for industrial and domestic heating purposes is amongst the revolutionary developments anticipated in consequence of recent research at Leeds University. Means have been discovered by which gases can be made to "burn" without a flame and yield temperatures that have been hitherto unattained by gaseous combustion. Details of the phenomenon of flameless heat which underlies this discovery were given before the Cavendish Society at Leeds University recently by Professor W. Bone, D.Sc., F.R.S., the professor-elect of fuel at the Imperial College of Science and Technology. These results, Professor Bone stated, were the outcome of many years' scientific research upon "the accelerating influence of hot solids upon gaseous combustion," conducted by himself and Mr. C. D. McCourt, in continuation of the investigations by many prominent scientists during the early part of last century.

The distinguishing feature of the new process is that an explosive mixture of gas and air, when caused to burn without a flame in contact with a granular incandescent solid, resulted in a large proportion of the potential energy of the gas being converted into radiant form. The advantages: (1) That combustion is greatly accelerated by the incandescent surface, and, if so desired, may be concentrated just where the heat is required; (2) the combustion is perfect, with a minimum excess of air; (3) the attainment of very high temperatures is possible without the aid of elaborate "regenerative" devices, and (4) owing to the large amount of radiant energy developed, transmission of heat from the seat of combustion to the object to be heated is very rapid.

The process has been industrially applied in two principal forms. In the first, or diaphragm method, a scientifically proportioned mixture of gas and air is passed under slight pressure through a porous screen of fireproof material. Once the surface of the diaphragm attains incandescence, the gases burned without flame on the surface of the screen. The actual combustion is confined within a very thin layer below the surface, and a wall of fire, but without flame, can be steadily maintained as long as required. Combustion is not only perfect, but is independent of the nature of the external atmosphere. This method is specially adapted to such operations as grilling and roasting, and to the evaporation of liquids from above. In the second method, a prearranged mixture of gas (or vaporized oil) is injected at high speed through a jet into a bed of granular fireproof material which surround the body to be heated. So great are the temperatures obtained by this method that the greatest difficulty is experienced in obtaining material to withstand the heat. Not only has temperatures exceeding 360° Fahr. been secured with coal gas, put the gas consumption requisite to maintain any given temperature is only about half that required in similar furnaces fired by flame contact.

If the claims for this method are fulfilled in its practical commercial application, a vast improvement in the heat efficiency of gas fuel will result. Its use under industrial conditions will be viewed with interest. The value of technical research and investigation is becoming more and more pronounced each year. A university at the present time which does not strive to aid human knowledge and endeavor by the carrying on of research for the purpose of improving industrial and manufacturing processes is not serving the best reason for its existence. There is room for vast improvement in our Canadian universities in this respect.

EDITORIAL COMMENT.

We are glad to note that the Council of the city of Toronto are considering a proposal to limit the height of buildings there to ten stories. We have commented in *The Canadian Engineer* many times on the evils resulting from the erection of high buildings. There is little justification for the existence of a building over ten stories high, and there are many reasons against their use.

* * * *

The Commission of Conservation are doing good work throughout the Dominion along many lines. It is to be hoped, however, that the Government will soon appreciate the necessity for adequate measures with regard to the question of regulation of stream flow and the provision of storage reservoirs. In the near future this question will have to be taken up; in fact, it is necessary now. Little work can be done on it, however, in a practical way until investigations covering the rainfall, run-off, and stream flow have been made, and all the available records compiled and brought up to date. Some of this work has been done by the different Provincial authorities, but the work should logically come under, and will be best done, by a central body, such as the Commission of Conservation.

STREET SPRINKLING IN ST. PAUL, MINN.*

By C. L. Annan, M. Am. Soc. C.E.

For years the citizens of St. Paul put up with unsatisfactory street sprinkling. In the earlier years the work was done by contract, the cost being roughly assessed, at considerable expense, against the property supposed to be benefited. Then, as a substitute, an annual appropriation was included, for a few years, in the general tax levy to meet the cost of springling by day labor. The result was intolerable. Finally, at the general election in May, 1908, a sprinkling amendment was submitted to the people, and in 1909 the commissioner of public works took charge of street sprinkling under this amendment.

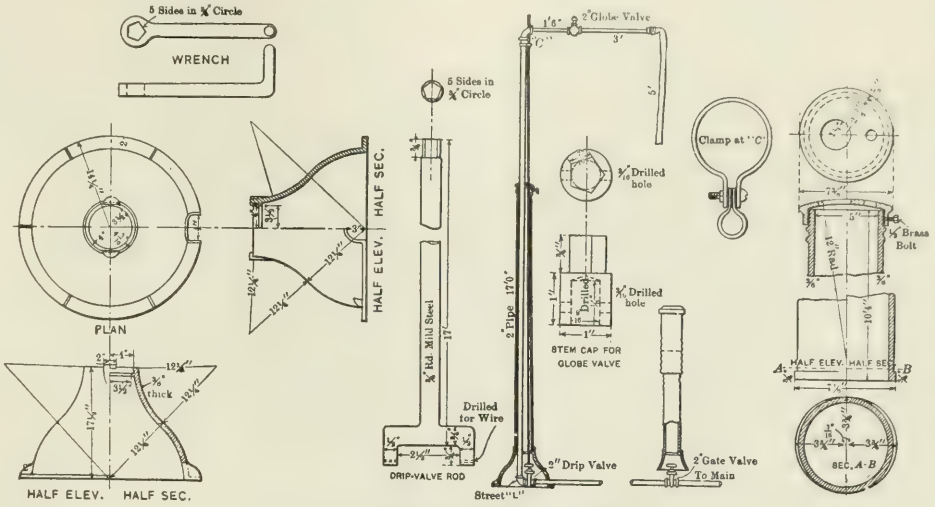


Fig. 1.—Stand-Pipe and Gate-Box.

The system inaugurated at that time has been fairly perfected, and it has been demonstrated that systematic attention to details has brought results at least commensurate with the cost.

Form 150. 12-5-1911 2M.

DEPARTMENT OF PUBLIC WORKS

ST. PAUL, MINN.

DAILY REPORT—STREET SPRINKLING

May 18 191/

District No. 5 Route No. 1 Tank No. 21 Driver Karl Yaeger

Trip No.	STREET	FROM	TO	Single Trips per day	Length
	Trip Number 1 2 3 4 5 6 7 8 9 10				
	Single Trips 4 " " " " " " " " "				
		2	25	G. Retrowske	
	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25				
	4 " " " " " " " " " " " " " "				
		3	40	John Beke	
	26 27 28 29 30				
	" " " " 8				
		4 1	26	Fred Mirke	
	31 32 33 34 35 36 37 38 83				
	" " " " " " " " "				
31	Indiana from	So Robert to	Hyde	4	Discontinued
83	Indiana "	So Robert "	So Wabasha "	4	Begun
84	Indiana "	So Wabasha "	Hyde (Transferred to Route 7)		
	Note: Routes 5-9 inclusive on next sheet		Total		

I certify the above to be correct

Inspector

Fig. 2.

The amendment provided for an appropriation of $[illegible], for the first year and an additional $40,000 for the second year. By that time the system should be smoothly running under the revolving fund fed by the assessment of the property benefited.

The third season under the new law opened with about 230 miles of streets to be sprinkled. New routes were added from time to time and a few were discontinued, resulting in a total gain for the season of about 9 miles. There is generally strong opposition to the discontinuance of a route once started.

From two to eight trips, depending on the nature of the street surface and the amount of traffic, are made each day. There are nine sprinkling districts, each under the supervision of an inspector at $75; a chief inspector or overseer at $110 is also employed. The ten inspectors report daily. The chief inspector advises and assists local inspectors and makes special examinations. The inspectors' reports are tabulated daily; all complaints are investigated, and the written reports are filed for reference. The foreman of stand-pipe construction and repair crews receives daily instructions, and the yardmaster returns a daily statement of sprinkler distribution and repairs. Careful itineraries on each team route are taken from time to time, and, in short, the head of the department is intimately informed of all details concerning equipment and operation.

DISTRICT NO. 5. TRIP NO. 82 WARD NO. 6 STREET State.

ROUTE NO. 2 FROM Louisa TO Concord

REGULAR TRIPS 4 NUMBER OF TIMES SPRINKLED

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MAR.																															
APRIL	✓	×	×	✓	✓	×	×	✓	×	×	✓	×	×	✓	✓	✓	✓	2	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MAY	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	2	×	✓	✓	×	×	✓	×	2	✓	✓	2	×	✓	2	✓
JUNE	✓	×	×	×	✓	✓	✓	2	✓	✓	✓	✓	✓	✓	✓	✓	×	2	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓		
JULY	✓	✓	✓	×	×	✓	✓	2	×	✓	✓	✓	✓	✓	✓	✓	✓	×	×	✓	✓	✓	×	×	2	✓	✓	×	✓	✓	✓
AUG.																															
SEPT.																															
OCT.																															
NOV.																															

Form 152 5-21-1911. 3M. MEMORANDUM NOS. 145

Fig. 3.

In assessing the cost of the work, the abutting frontage, number of trips per day, and length of time sprinkled, are taken into consideration. For the season of 1911, 43 assessment rates thus resulted, ranging from less than 1 cent to 11½ cents per front foot of abutting property. The cost of water is not included in the assessment, the city charter so providing.

Water sprinkling of macadam was suspended early in the season by oil spraying. It was estimated that about 1/5 gallon per square yard of a 20 per cent. liquid asphalt might be applied three times during the season at a cost not to exceed that of water sprinkling for the same period. The latter part of the season being usually wet, comparatively few streets required the three coats of oil.

* Paper to be presented Sept. 18th, 1912, to the American Society of Civil Engineers, and printed in the Proceedings of the Society for May.

The sprinkling wagons are city property; 40 new and 31 second-hand sprinklers, varying in capacity from 600 to 750 gallons, were purchased in 1903. Twelve 750-gallon tanks were added in 1909, and as many more in 1910. These 95 sprinklers allowed a 10 per cent. reserve. All were in good repair after a thorough overhauling during the winter.

Teams were used for 7 days in the week at $100 per month, rain or shine, under an agreement with the Teamsters' Union. Previous to April 1st, teamsters were allowed $4 per day for actual time.

Inspectorships, formerly political sinecures, were transformed to realities. Consistent daily reports, investigations of complaints, route itineraries, and first-hand information as to condition of sprinklers and stand-pipes, require a certain amount of attention.

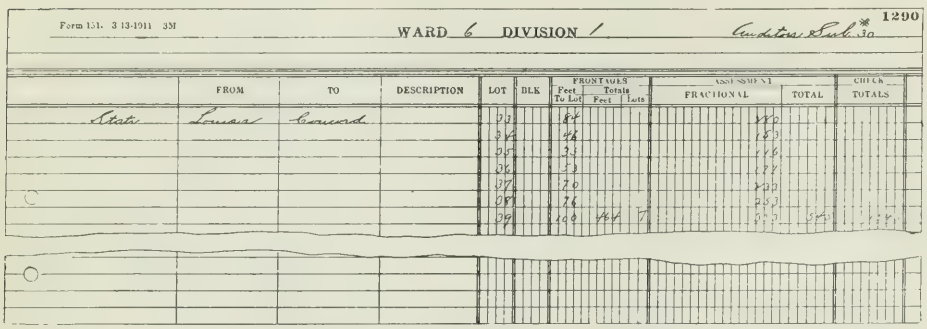


Fig. 4.

Five men at $2 and a team at $3 keep the stand-pipes in repair under the supervision of a foreman, who also attends to the maintenance of the public drinking fountains. This force also moved 16 stand-pipes from one point to another and erected 17 new ones in 1911. A stand-pipe, installed, (Fig. 1) costs about $60. The top valves are removed in October to prevent damage by freezing, and are replaced in April, an underground valve being used in March and November. There are 463 stand-pipes now in service.

The stand-pipe is quite generally regarded as a nuisance, and much opposition is met in locating it. It is not so much its unsightliness as the frequent presence near it of the heavy sprinkler, the standing horses, and the general sloppiness that makes is objectionable.

For washing ice, mixing cement, and other purposes, the stand-pipe is a great convenience to any outsider with a pipe-wrench. The water department and the police had long overlooked this kind of larceny, but a few arrests by special officers of the sprinkling department, and a few trials and convictions, now and again, somewhat abated this nuisance of mud and damaging misuse.

The method of assessing is as follows: A clerk, at $60, enters the daily report (Form 150, Fig. 2) on Form 152, Fig. 3, and indexes complaints and special orders to inspectors by number on the same form. Complaints are taken in duplicate on a general department form, the duplicate being held against the inspector until he turns in his report.

Form 152 is arranged in a check file divided into districts by tab cards of a distinctive color. The districts are subdivided into routes by cards of another color, one compartment in each district being reserved for "dead" trip slips. The current trip slips will not average more than ten to a route, so they are readily accessible, though the aggregate may be considerably more than 1,000.

Trip and route numbers may be changed on a trip slip (Form 152) but a change of limits necessitates new slips and cross-references and the consigning of the obsolete slip to the "dead" division until required for assessment purposes. All assessment forms are handled on the loose-leaf system.

Two men, at $80, are employed from March 15th to August 1st in making a transcript from the county auditor's records on Form 151 (Fig. 4) and preparing assessment sheets (Form 166, Fig. 5). The force is then doubled to make the assessment, post, and check it, the work to be completed early in October.

The assessment rate, A, per front foot of property abutting on any particular section of sprinkled street is derived as follows:

D = trips per day on the particular route,

M = sprinkling period, in months and tenths for the same route,

C = D × M (nearest integer),

F = total frontage on same route,

P = C × F,

S = sum of products, P, for all routes,

T = estimated total cost of sprinkling all routes. (From the five months actual record a close estimate can be made for T).

$$R = \frac{T}{S},$$

Then $A = C \times R$.

An idea of the method of procedure and of the relation of volumes may be obtained by particular reference to the assessment of 1911. The daily record, on Form 152, was summarized on Form 154 (Fig. 6), embracing 1,439 sheets in twelve groups, one for each ward, each group arranged alphabetically by street names and bound with flat-head fasteners. The coefficient, C, having been determined for each slip, the 1,439 slips were rearranged in 43 groups,

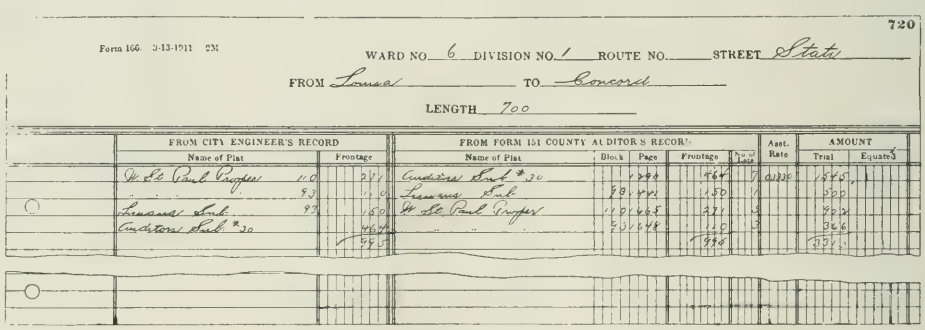


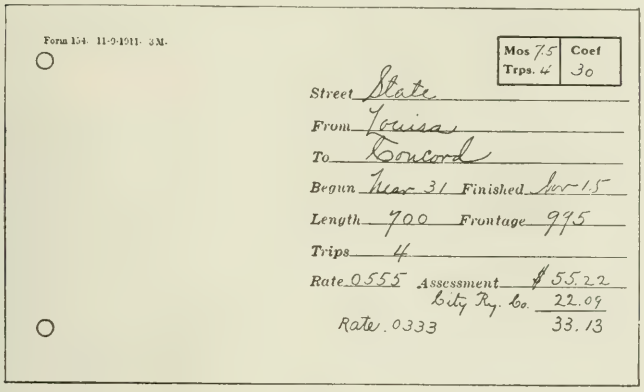
Fig. 5.

corresponding to the variations of C. A five-column table was then prepared with a line for each value of C, thus:—

C	F	P	F × R	C × R
1.....	34,006	34,006	62.91	0.00185
2.....	69,252	138,504	256.63	0.00370
		and so on, to		
62.....	62,965	3,903,830	7,222.09	0.11470
	2,567,815	50,529,857	93,480.24	

The total of Column P is S. The total of Column F × R is T. R is obviously the first item in Column C × R. R being constant, there are as many values of A as there are of C and F × R, for each group is checked by the total.

The entries on Form 154 are now completed, and the slips are rearranged in ward groups. In the meantime, Form 166 has been prepared to correspond with each sheet of Form 154, of which it is an extension applied to the property to be assessed. Form 166 is arranged alphabetically. When complete, the sheets are paged consecutively from the first sheet of Ward 1 to the last sheet of Ward 12.


Form 154. 11-9-1911. 3M.

Mos 7.5	Coef
Trps. 4	30

Street State
From Louisa
To Concord
Begun Mar 31 Finished Nov 15
Length 700 Frontage 995
Trips 4
Rate .0555 Assessment $55.22
City Ry. Co. 22.09
Rate .0333 33.13

Fig. 6.

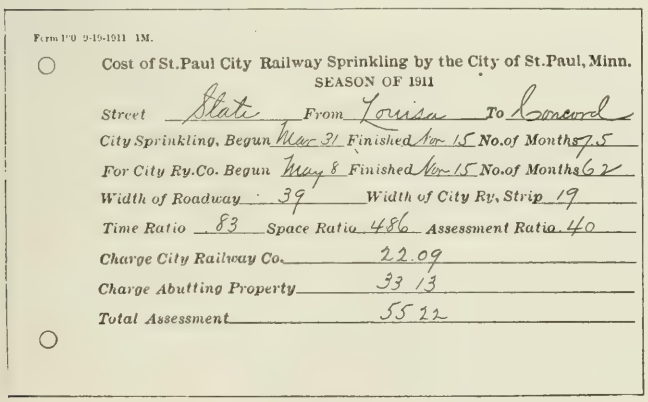
The assessment is finally made on Form 151, there being as many sheets of this form as there are block numbers involved on the various plates and subdivisions named on Form 166.

For instance, on page 720 of Form 166 there are four blocks of property containing lots to be assessed. There will consequently be four corresponding sheets of Form 151. These sheets are arranged alphabetically by plot names in ward groups, and they are also paged consecutively.

Page 1290 (Fig. 4) is a specimen sheet whereon the seven lots in the Auditor's Sub. No. 30, noted on the first line of page 720, are entered in detail. The 1911 assessment contained 3,472 sheets of Form 151.

The cost of making the assessment of 1910 was a little more than 2 per cent., but City Railway complications raised this ratio to more than 3 per cent. in 1911.

Early in May, 1911, the Supreme Court of the State decreed that the St. Paul City Railway Company must at once comply with the ordinance of October, 1909, requiring this company to sprinkle its tracks. As an immediate alternative, the company agreed with the commissioner of public works to pay the sprinkling department for doing the work. The cost of sprinkling streets traversed by the City Railway was to be prorated as to time and space from the totals of the general assessment for the same streets. Form 190 (Fig. 7) was provided for this record.


Form 190 9-19-1911 1M.

Cost of St. Paul City Railway Sprinkling by the City of St. Paul, Minn.
SEASON OF 1911

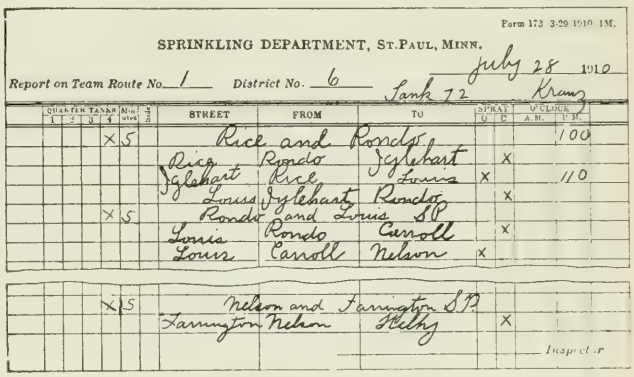
Street State From Louisa To Concord
City Sprinkling, Begun Mar 31 Finished Nov 15 No. of Months 7.5
For City Ry. Co. Begun May 8 Finished Nov 15 No. of Months 6.2
Width of Roadway 39 Width of City Ry. Strip 19
Time Ratio .83 Space Ratio .486 Assessment Ratio .40
Charge City Railway Co. 22.09
Charge Abutting Property 33.13
Total Assessment 55.22

Fig. 7.

As soon as arrangements could be made, the City Railway Company sprinkled many miles of its track space with road oil.

The occasional itinerary which has been referred to has proved to be a practicable and an excellent feature. It was called for at irregular intervals, and the returns assisted in determining the efficiency of both teamsters and inspectors. Each teamster and inspector is furnished with a specific route sheet, and the care taken to equalize routes is generally appreciated and tends to the good of the service. The routes as traveled are reported on Form 173 (Fig. 8). They are platted on light blue prints. A summary is made of the number of tanks of water used and of the feet of effective and idle travel in a half day. The 45 sq. miles of sprinkling area are covered by 34 tracings (8½ by 13½ in.) on a scale of 600 ft. to 1 in., and from these tracings the blue prints referred to are made as required.

Among the many owners of the 50,000 lots, more or less, assessed, there are many complainants who desire to know the particulars, and, for the benefit of this class, a special form has been prepared. Occasionally, a correction is necessary; there were only twenty on the first assessment made under this system.


Form 173 3-29-1910. 1M.

SPRINKLING DEPARTMENT, ST. PAUL, MINN.

Report on Team Route No. 1 District No. 6 July 28 1910
Tank 72 Krum

Quarter Tanks 1 2 3 4	No. of Block	STREET	FROM	TO	Spray U	Spray D	O'Clock A.M.	O'Clock P.M.
		Rice and Rondo						
×	5	Rice	Rondo	Dyleheart		X		100
		Dyleheart	Rice	Louis	X			
		Louis	Dyleheart	Rondo		X		110
		Rondo	Land Louis	SP				
×	5	Louis	Rondo	Carroll		X		
		Louis	Carroll	Nelson	X			
		Nelson and Farrington SP						
×	5	Farrington	Nelson	Selby		X		

Inspector

Fig. 8.

The assessment for each ward is cross-checked and balanced to a cent. A concluding word may be said as to the daily reports, Form 150 (Fig. 2). Each section of street has its trip number. The small figures under the trip numbers show the number of trips actually made for the day. Under Route 4 it will be noted that Trip No. 31 lacks the sub-number. The explanation immediately follows. To write "31" is equivalent to writing "Indiana Avenue, from South Robert Street to Hyde Street." On May 18th Trip No. 31 was divided. A portion of it (No. 84) being transferred from Route 4 to Route 7.

Each inspector keeps a consecutive list of last numbers in his district and can thus assign a new number when necessary.

MOVEMENT TO IMPROVE INDUSTRIAL CONDITIONS IN EASTERN CANADA.

Colonel Vince, who is a member of the public utilities commission of New Brunswick, has stated that natural gas will revolutionize industrial conditions in the province, if it is found in sufficient quantities to supply St. John and other places as it does Moncton at the present time. Borings are being continued in the oil region in Albert county and will probably also be made in King's county.

THE ALLOYS OF ALUMINUM AND ZINC.

At a recent meeting of the Institution of Mechanical Engineers, Dr. Walter Rosenhein and Mr. S. L. Archbutt, of the National Physical Laboratory, presented the Tenth Report to the Alloys Research Committee of the Institution on the "Alloys of Aluminum and Zinc."

The principal results obtained in the investigations described in the present (Tenth) Report to the Alloys Research Committee are briefly summarized as follows:—

(1) The Constitution of the Alloys.—This is only briefly dealt with in the report, since a full account of the metallographic study of the aluminum-zinc system has already been published elsewhere. The new equilibrium diagram arrived at by the authors is reproduced, showing the occurence of reactions and the formation of a definite compound (Al_2Zn_3) whose existance had not previously been established. From the equilibrium diagram it appears that all the alloys containing more than 40 per cent. of zinc undergo transformation at a temperature of 256 deg. C. (493 deg. Fahr.). As regards the alloys at and near the aluminum end of the series, the new equilibrium diagram establishes their "solidus curve" or temperature of complete solidification, and also exhibits certain minor transformations which, although shown not to be due to a change in the pure aluminum-zinc system, always occur in commercial alloys at temperatures near their melting-point. The alloys containing less than 40 per cent. of zinc are shown to be simple homogeneous solid solutions, although it is possible that the inversion of 256 deg. C. also occurs at this end of the series. When cast in chill moulds, the microstructure of these alloys exhibits the sharply "cored" structure usually found in rapidly cooled solid solutions having a long range of solidifications. In sand-castings this coring is less sharply defined and the whole microstructure is on a larger scale. The "cores" are entirely removed by prolonged annealing at such a temperature as 400 deg. C. (752 deg. F.), but they are removed rapidly and completely by the rolling process. Photomicrographs of the hot-rolled alloys, especially after annealing, containing up to 25 per cent. of zinc, exhibit the typical polyhedral structure of a perfectly homogeneous solid solution, although the scale of the crystals varies considerably according to the exact mode of treatment which the material has undergone.

The Study of the Cast Alloys.—Tensile tests on sand and chill-castings of a series of alloys covering the entire range of the binary system are given, both in tabular and graphic form. The tensile strength of sand-castings shows a steady increase up to a concentration of 50 per cent. of zinc, when an ultimate stress of 18.7 tons per square inch is reached; there is then a slight fall of strength with further increase of zinc-content, followed by a rise to a second maximum near 75 per cent. of zinc, a concentration which corresponds approximately to the composition of the compound Al_2Zn_3. The highest ultimate stress reached is 18.9 tons per sq. in. The table and curve representing the results of tests on chill-castings is some what different in type, three maxima being observed, namely, the first at 30 per cent. of zinc with an ultimate stress of 17.9 tons per sq. in., the second at 50 per cent. with 21.6 tons per sq. in., and the third at 75 per cent. with 20.1 tons per sq. in. The yield-points for both sand and chill-castings are recorded as observed, but the observations were found to be somewhat uncertain in the case of the cast alloys.

In discussing the results of tensile tests on the present series of alloys the authors have used the term "Specific Tenacity," to denote a quantity which is proportional to the tensile strength and inversely to the specific gravity; this has been calculated by dividing the ultimate stress of a given alloy in tons per sq. in. by the weight of a cubic inch in pounds. The quotient is the breaking load in tons of a bar of the material whose cross-section is such as to make the weight of the bar 1 lb. per in. length. From the point of view of tensile strength alone this figure may be regarded as representing the value of any structural material, and allows of comparisons on a correct basis between materials of widely different specific gravity, such as these light alloys and steel. In the cast alloys the specific tenacity is found to reach its maximum for both sand and chill-castings in an alloy containing approximately 26 per cent. of zinc. The value attained is just over 150, as compared with a maximum value of 126 reached by the light alloys described in the Ninth Report. In the light alloys of aluminum with copper alone the specific tenacity of casting does not exceed a value of 99.

Compression tests on a number of chill and sand-castings of the alloys, including some of higher zinc-content, have been made. These tests show that in general terms the behavior of the castings under compression is approximately proportional to their behavior under tension. The highest yield-stress under compression was obtained with alloy No. 55 in the chill cast condition, giving a stress of 22.96 tons per sq. in. It is curious to find, however, that the chill-castings are decidedly inferior to the sand-castings until a zinc-content of about 50 per cent. is passed.

The question of the possible "ageing," or even gradual spontaneous disintegration of the aluminum-zinc alloys has also been studied in connection with the sand-cast material, tensile tests of some of the alloys being repeated on specimens which had been kept for over fifteen months, but no signs of any change were observed.

Study of the Wrought Alloys.—Billet of the alloys containing up to and including 26 per cent. of zinc were cast at the Laboratory and were rolled and drawn to various sizes, including wire and sheet, at the Milton Works of the British Aluminum Company. Hot-rolling was found possible with all these alloys, but not with an alloy containing 30 per cent of zinc.

Tensile tests on a representative series of alloys lying between the limits of composition just named were made on material in the form of (1) bars hot-rolled to 1¼ in. diameter, (2) bars hot-rolled to ⅞ in. diameter, (3) bars hot-rolled to ½ in. diameter, (4) bars cold-drawn to 13/16 in. diameter, (5) bars drawn with annealing to 13/16 in. diameter, (6) cold-drawn wire 0.1285 in. diameter, and (7) sheet of 0.14 and 0.07 in. thickness. In addition, the material in the form of ⅞ in. bars hot-rolled, 13/16 in. cold-drawn, hot-rolled ½ in., and wire, as well as sheet of both thicknesses, was also tested after annealing for one hour at 400 deg. C. The tensile tests on all the hot-worked material gave very uniform and consistent results which can generally be represented by reasonably smooth curves when the data are plotted against zinc-content. The yield-points in these tests, as contrasted with those on castings, are well-defined and as regular as the results for ultimate stress.

In the form of 1¼ in. hot-rolled bars, the alloy No. 26 attains a tensile strength of 27 tons per sq. in., with a yield point of 25 tons per sq. in. and an elongation of 16.5 per cent. on 2 in. Both the tensile tests on 1¼ and on ⅞ in. hot-rolled bars give curves of ultimate stress plotted against zinc-content which are very similar to one another, but it is a striking feature of these alloys that the curve for the smaller section lies above that for the larger only up to a zinc-content of about 12 per cent.; above that concentration the 1¼ in. bars give higher ultimate stresses than the ⅞ in. bars. The results of tests on still smaller sizes of material, even including the hard-drawn wire, show corresponding results, although the crossing-point of the respective curves

differs from one size of material to another. The general conclusion is demonstrated that the beneficial effect of "work" on these alloys diminishes steadily with increasing zinc-content, until the 25 and 26 per cent. alloys are reached, in which we find that the highest ultimate stress is always given by the 1¼ in. hot-rolled bars. These alloys, richer in zinc, therefore, present the unusual property that cold-drawing a bar from 1¼ in. to 13/16 in. diameter, although it raises both yield-point and elastic limit and lowers elongation and reduction of area, actually reduces the ultimate stress.

The condition (excluding wire) of highest tensile strength, together with the yield-stress and elongation corresponding to that condition, are given for a series of typical alloys in Table 1.

Table 1.

No. of the Alloy (also per cent. Zn)	Condition for Highest Ultimate Stress	Ultimate Stress	Yield-Point	Elongation on 2 inches
		Tons per sq. in.	Tons per sq. in.	Per cent.
5.....	⅞-in. hot-rolled bar	8.94	7.4	26
9.....	⅞-in. hot-rolled bar	11.17	6.98	38*
11.....	⅞-in. hot-rolled bar	13.78	9.42	35*
13.....	13/16-in. cold-drawn bar	14 73	12.80	19.5
17.....	1¼-in. hot-rolled bar	19.85	13.20	22
20.....	1¼-in. hot-rolled bar	22.64	17.3	20.5
26.....	1¼-in. hot-rolled bar	27.09	25.00	16.5

* On 1 inch.

The tensile tests on annealed material were undertaken principally to ascertain whether the peculiar effects of "work" mentioned above persisted after annealing, and the results are discussed with reference to the resulting microstructures. It was found that the "hot-rolled" materials exhibited a considerable amount of deformation in their constituent crystals, and that this deformation was entirely removed by annealing, although the scale of the resulting structure differed widely according to the treatment which each specimen had received. In general terms it was found that the tensile strength of the annealed materials was not strictly proportional to crystal size, but that the more severely worked material always exhibited better results after annealing than less severely treated metal. The highest ultimate stress in annealed material of the present series of alloys was obtained from alloys No. 20 in the form of annealed cold-drawn wire, the value being 21.1 tons per sq. in., but it must be noted that the higher alloys of the series (Nos. 25 and 26) were not included in all the tests on annealed material.

The tests on wire and sheet gave results which have already been referred to in connection with the effect of work and of annealing. Sheets were rolled from alloys Nos. 15 and 20; the former rolled well, but the latter cracked somewhat at the edges. The tensile tests show considerable variations as regards yield-points between longitudinal and transverse tests, although these are obliterated to a considerable extent after annealing. The yield-stresses, however, gave very erratic results, and this is probably to be ascribed to slight surface cracking of the metal. In the cold-rolled condition, alloys No. 20, in the form of sheet 0.07 in. thick, gives an ultimate stress of 23 tons per sq. in., but there is little or no elongation in this condition. After annealing the ultimate stress falls to 18 tons per sq. in., but the elongation reaches 10 per cent. on a longitudinal and 6.25 per cent. on a transverse test.

As regards the tests on the alloys in the form of wire, it was found possible to obtain even alloys Nos. 25 and 26 in this form, but the results given by these were disappointing, since they were lower than the tests obtained with 1¼ in. hot-rolled bars. In the annealed condition, however, these wires give results which appear to be promising; thus No. 19 gives an ultimate stress of 21 tons per sq. in. with 17.7 per cent. of elongation. It is interesting to note that the tests on annealed wire exhibit a well-defined maximum in tensile strength at or near a concentration of 20 per cent. of zinc.

Tensile tests at high temperatures were made on a series of the alloys in order to ascertain the effect of zinc-content on the rate of loss of strength of these alloys with increasing temperature. Most of the alloys were tested up to 200 deg. C. (392 deg. Fahr.), but in two cases considerably higher temperatures were employed (up to 595 deg. C.). In every case it is found that there is a rapid fall in the yield-stress and ultimate stress with rising temperature, even 50 deg. C. producing a marked effect. The rate of loss of strength varies according to the composition of the alloy; thus at 100 deg. C. the alloys containing up to 13 per cent. of zinc have lost about 36 per cent. of their tensile strength at the ordinary temperature; the alloys containing from 15 to 17 per cent. show a loss of 44 to 52 per cent., but this figure again diminishes to 26 per cent. for alloy No. 26. These relative rates of loss are confirmed at higher temperatures. At still higher temperatures the strength of the alloys becomes exceedingly small, but they exhibit a remarkable degree of ductility as measured by elongation and reduction of area; the latter in some cases is so great that the fracture is drawn down to a sharp point, while the elongation in one instance reached 133 per cent. Forging tests, however, show that this extreme ductility exists only under "static" loads, and that the alloys which draw out to the fine points in the testing machine are broken into small fragments if struck sharply with a hammer at the same temperature.

The elastic properties of the alloys have been determined both for the hot-rolled and cold-drawn materials. They exhibit a satisfactory elastic behavior and show well-defined elastic limits, which increase regularly with the zinc-content and consistently with the ordinary yield-point determinations. The elastic moduli of all the alloys are almost identical, lying near the value 9×10^6, a low value which may prove a disadvantage for certain possible uses of the alloys.

Torsion tests have been carried out on specimens cut from the alloys in the form of 1¼ in. hot-rolled bars, comparison of the results with those of tensile tests shows that the torsional strength, although it increases considerably with increase of zinc-content, yet does not increase as rapidly as the tensile strength. The ratio of the maximum stresses under the two forms of test falls from 1.10 for alloy No. 9 to 0.76 for alloy No. 25.

The hardness numbers of the alloys, again in the form of 1¼ in. hot-rolled bar, have been determined by the Brinell method under loads of 1,000 and 3,000 kg. respectively and by the Shore scleroscope. The proportionality between the hardness numbers and tensile strength is found in these alloys to be only of a general kind, the shapes of the respective curves being notably different.

Compression tests have also been made on the wrought alloys. The results are in strict conformity with those of tensile tests, although the compression yield-stresses are always slightly higher than those found in tension.

Dynamic tests have been carried out on the alloys both with the machines designed for that purpose at the National Physical Laboratory under the direction of Dr. T. E. Stanton, and also by the kindness of Professor J. O. Arnold at the University of Sheffield. The tests made at Teddington include direct alternations of stress, repeated-bending impact and single-blow impact.

The tests in alternations of direct stress give a series of results for the safe range of alternating stresses for the

alloys, and this curve lies considerably below that of the static elastic limits. These ranges, although low when compared with the ordinary tensile test results, yet indicate a very decided advance on other light alloys which have been described in the Ninth Report. The best of those alloys (of aluminum with copper and manganese) showed a safe range of 9.4 tons per sq. in., while the best of the present series has a range of 12.0 tons per sq. in.

Alternate-bending impact tests made with a weight of tup of 4.71 lbs. and heights of fall of 1.0 in. and 0.71 in. respectively. Both sets of tests give curves of very similar shape which show that after 15 per cent. of zinc the resistance to this test is strictly proportional to the zinc-content of the alloy. Of the present alloys, No. 9 shows a resistance practically equal to that found in the best of the light alloys described in the Ninth Report (about 600 blows with a fall of 0.71 in.), while the best alloy of the present series (No. 25) required 3,400 blows for fracture. This power of resisting repeated impact is particularly noteworthy in view of the fact that the aluminum-zinc alloys are frequently spoken of as being weak under shock.

Single-blow impact tests, made on the Izod machine, show that the work absorbed by fracture reaches a maximum for a zinc-content lying between 15 and 20 per cent. This is in accordance with the fact that such tests are affected by both tensile strength and ductility, so that the increased tensile strength of the alloys containing more than 20 per cent. of zinc is more than outweighed by their lower ductility so far as this test is concerned. As compared with the light alloys previously studied, the present series are decidedly superior, although the difference is not so marked as under some of the other tests.

Under Professor Arnold's alternate-bending test, the alloys gave remarkably uniform results, but the curve of number of alternations endured falls rapidly with increase of zinc. Professor Arnold remarks that the resistance of these alloys to his test varies from ⅛ to ¼ that of the heat-treated best mild structural steel. It is interesting to note, in comparing the results of the three last-mentioned forms of dynamic test, that the curves representing their results are closely related to the curves of ultimate stress and elongation or reduction of area as shown by tensile tests. Thus the repeated-bending impact tests give a curve which is closely proportional to that of ultimate stresses, while the results of Professor Arnold's tests are proportionate to the ductilities of the alloys as shown by elongation or reduction of area. The single-blow impact tests, on the other hand, appear to be proportional to the sum of these two properties.

In view of the results of all the mechanical tests the authors arrive at the conclusion that an alloy containing about 20 per cent of zinc probably represents the best combination of properties obtainable in the simple binary aluminum-zinc series.

Corrosion tests on specimens of these alloys exposed to the sea have been carried out for a period of over 500 days, and the results show that the rate of loss of weight under such exposure increases with increase of zinc-content. The actual rate of loss, however, is not as great as might have been anticipated, varying, when allowance for the difference of density is made, from 1½ times that of Naval brass to 1½ times that of Muntz metal. The authors, however, regard their corrosion tests as purely preliminary, since the alloys were used in the cast state, while subsequent study suggests that annealed material would show considerably less corrosion. The method of measuring corrosion by loss of weight is also regarded as inadequate for the study of these alloys, and further corrosion tests are being undertaken.

A general feature of some importance in connection with all the alloys described in the present report, and particularly with those containing from 10 to 30 per cent. of zinc, is the great facility with which they can be worked by machine tools of all descriptions, in most cases without the use of any lubricant. Turnings of exceptional length and strength have been obtained from several of these alloys. The machined surfaces retain their brightness in the air of the laboratory for many months without protection of any kind.

Attention is directed to the Appendix, in which the authors give a preliminary account of the properties of a tenary alloy of aluminum with zinc and copper (alloy No. 25/3) containing approximately 25 per cent. of zinc and 3 per cent. of copper. This alloy, which can be rolled hot, although special care is required in dealing with it, gives remarkable results under mechanical tests. An ultimate stress of 34 tons per sq. in. has been attained with this material, while its resistance to repeated-bending impact is over 4,500 blows, as compared with 3,400 of the best of the binary alloys. Tabulated results of tests made on this alloy are given, but a fuller discussion of its properties is postponed until a systematic study of these ternary alloys has been completed.

ELECTRICALLY OPERATED VALVES.

By H. M. Cassman.

Valves of 24 in. diameter and larger are usually operated other than by hand, for the reason that generally such valves must be closed in a very short time, which is impossible by hand operation, and also because such valves are frequently located in out-of-the-way places, and are more conveniently controlled from some operating point more or less remote from the valves.

As large valves usually control very important service connections it is essential that the electrical equipment of these valves be dependable. To guard against failures the valves should be inspected and tried out regularly, particularly where they are likely to remain in one position for long periods.

The power required to open a valve is a maximum when starting the valve from its seat. After the gate has been opened, say, one-fourth, comparatively little torque is required to complete the operation. The proportion of starting to running torque varies with the construction of the valve, the amount of corrosion and the condition of the valve seat. When closing hydraulic valves under pressure, the starting and running torques are comparatively small until the valve is about three-quarters closed. From that point on, the pressure on the gate increases approximately as a square of the decrease in the opening; consequently the torque at closing in such cases increases rapidly, but does not reach the value of the starting torque required to open the valve under the same pressure conditions.

To overcome the sticking of the valve when it is to be opened, the drive is sometimes provided with a lost-motion device, so as to give a hammer blow when starting the valve from its seat. With alternating-current motors such lost motion also allows the motor to develop a high speed, and, therefore, a greater torque before starting the valve from its seat.

Unless some provision is made for limiting the torque of the motor or controlling the circuit when closing the valve, it is possible to jam and injure the mechanism of the valve, making further operation difficult. A slip gear

* From a paper delivered at the Pittsburg meeting of the American Institute of Electrical Engineers, April 25th to 27th.

cannot be used for this purpose, as the slipping torque in opening will be practically the same as when closing, unless the gear be designed to act in the closing direction only.

Where compactness is a consideration the motor is rigidly attached direct to or on an extension of the valve casing. The motor and drive should be so arranged that there will be ample room for hand operation. An inclosed motor is preferred on account of exposure to dampness, water and flooding, enclosing being permissible without affecting the size of the motor, owing to the intermittent service. Terminals and wiring also must be protected against water and any mechanical injury which might result while repairs are being made to the valve.

A valve should not be overpowered by a motor, for the reason that there is considerable risk of damaging the valve, and should not be underpowered, because it increases the chance of failure when the conditions are extraordinary. The correct size of motor for the valve will very with the duty and the general conditions under which the valve operates.

Where there is any choice of system, the direct current is preferred in order to secure the advantages of a series-wound motor, giving a high starting torque and increased speed under light load. The commutator and brushes, however, are apt to give trouble in damp or wet locations. The alternating-current motor best adapted to valve operation is the squirrel-cage type because of its simplicity. The motor should be designed with a high resistance rotor to increase the starting torque.

For equivalent performance—that is the same assurance against failure of the motor to operate the valves—the alternating-current motor should be from 20 to 40 per cent. larger than the direct-current motor. In such applications motor efficiency does not enter, but operating efficiency does, and, therefore, it is economy to put on motors of greater capacity than would be actually required under ordinary conditions.

For remote control the ideal arrangement is one which permits of automatically starting and stopping the motor by simply throwing a switch or controller, and one that makes it impossibe to start the valve in the wrong direction and wreck some part of the valve or mechanism.

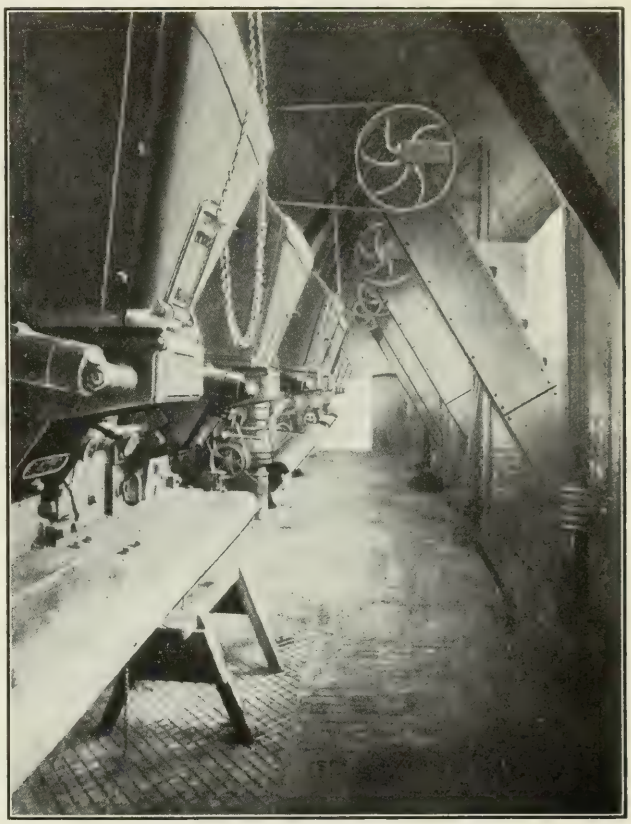
Where valves require direct-current motors larger than can be thrown directly across the line without resistance, such resistance should be designed to give the maximum torque required to open the valve and be retained permanently in circuit. As the motor speeds up, due to a decrease in load, a step of sufficient resistance should be inserted in series with the motor to prevent excessive speed at light load, to slow down the motor as the torque increases near the closing point, and to limit the torque finally should the valve seat itself before the motor is disconnected from the circuit. There are various schemes for obtaining this result with a two-point reversing drum controller or with a pilot switch control in combination with shunt and series-wound contactors. In either case, limit switches should be provided at each end of the travel.

For alternating-current motors the same general scheme can be used, as this type of motor will not increase in speed appreciably with change in load, but the resistance in the stator circuit will also have the effect of limiting the torque in closing the valve.

The limit switches can be designed to handle the motor current instead of the contactor exciting current. For small valves the limit switch is sometimes omitted and the motor allowed to increase its torque to the point of operating an overload circuit-breaker. Such an arrangement, however, is not fool-proof, in that it allows the operator to start the gate in the same direction at the end of its travel.

THE ALEXANDRA (NEWPORT AND SOUTH WALES) DOCKS AND RAILWAY.

The progress of Newport is a record of almost marvellous development and expansion. Newport is to-day the largest and most important town in the county of Monmouth, and it is a great deal more than that. It is one of the busiest and best equipped seaports in Europe, and is, moreover, located in one of the most "growing" districts in the world. Newport is, of course, an important industrial centre, with large ironworks and other manufacturing undertakings. The principal industry is the mining and exporting of coal. In a recently issued booklet on the port and its products, the writer graphically describes the uses to which the famous South Wales and Monmouthshire coal is put. He says: "The battleships of the world are bunkered with coal which has sailed down the Bristol Channel from Newport and her sister ports. This coal has



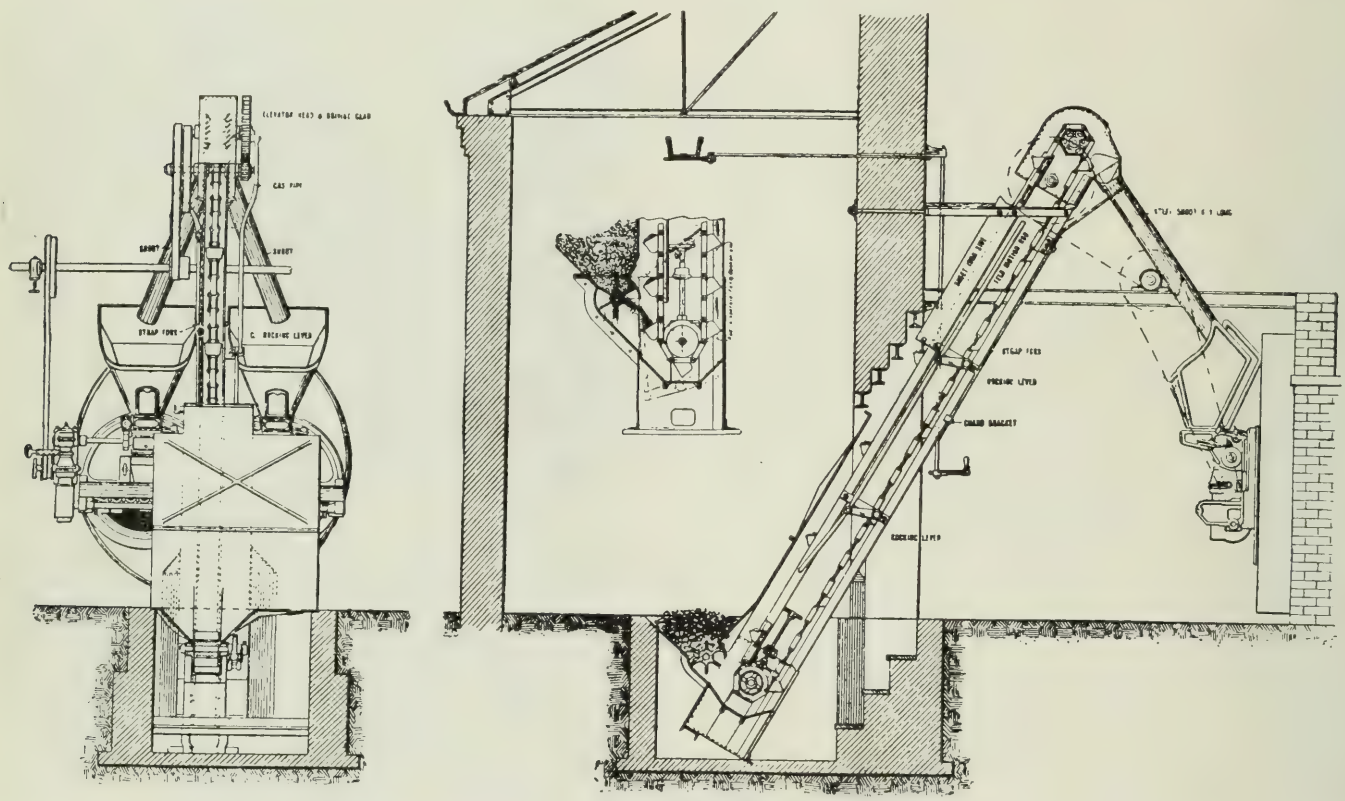
A Range of "Bennis" Stokers in the Boiler-House of the Alexandra Docks, Newport, Monmouthshire, England.

burned in all the naval battles of recent years, has been fired into a warship's furnaces by Royal hands, and has played its all-important part in the records won by leviathan liners."

The story of Newport's progress is worth reading, from the making of the first Newport dock of insignificant dimensions, and intended for coasting traffic, to the present time, when, as an ocean port of first importance, it demands attention and elicits admiration. Since 1905 it has been growing rapidly; 48 acres have been added to the deep water area, and a further 27 acres are waiting the admission of water as soon as the new deep water entrance dock is completed. This lock will be the largest of its kind in the world, measuring 1,000 feet long by 100 feet wide, with a depth of water on the outer cill at high water spring tides of no less than 45 feet, and 35 feet at high water neaps. Everything in connection with the lock will, as might be

expected, be on a comparatively colossal scale, including the gates and operating machinery. The completed portion of the dock is 3,700 feet long on the north side, while its maximum width is 1,050 feet. The south side of the dock is occupied by a concrete quay wall, a length of 2,250 feet having been equipped with a number of hydraulic cranes and an extensive transit warehouse, while the north side of the extension is equipped with four fixed coal hoists, erected on four concrete towers. The coal hoist structures rise to a height of about 100 feet above the coping of the piers; have a lift of 60 feet, and are capable of accommodating wagons of a gross weight of 23 tons, while provision has been made in the hydraulic cylinders to enable wagons up to 30 tons gross to be dealt with when required.

It is not intended to give here any detailed description of these huge docks, known as the Alexandra (Newport & South Wales) Docks and Railway. It is desired, however, to indicate the vastness of the undertaking which points to the enterprise of Viscount Tredegar, chairman of the Alexandra Docks Co., John Macaulay, Esq., general manager, and those associated with them in the scheme so ably carried out. As an instance of the care that has been exercised in all departments of the company's works to install only appliances best fitted to produce the desired results, mention must be made of the boiler-house. Steam is, of course, the "raison d'être" of every boiler-house, in spite of the fact that many boiler-house chimneys seem to suggest it is the emission of black smoke. In the boiler-house of the Alexandra Docks Company cheap steam is produced with the regularity of day and night. By cheap steam is implied steam that is manufactured from low-grade, low-price fuels, and that is steady and reliable in output. It must, moreover, be made without smoke. The accompanying illustration shows a range of five Lancashire boilers, fitted with "Bennis" stokers and self-cleaning compressed air furnaces manufactured by Ed. Bennis & Co., Limited, Little Hulton, Bolton, Eng., Canadian representative G. H. Tod, Toronto. The diameter of the flues in three of the boilers is 2 ft. 9 in., and in two of the boilers 2 ft. 11 in. The load carried is that of a hydraulic pumping station. Two tests were carried out here; one prior to the installation of the mechanical stokers, when the boilers were hand-fired; the other when the machines had been fitted. The latter was made on behalf of the Dock Company, by the staff of the British Engine, Boiler & Electrical Insurance Co., Ltd. The stoker-makers were represented. The duration of the tests was 7½ and 8 hours respectively. In the first trial three boilers were used; in the second trial two only were fired. The boilers are identical in design, with a diameter of 7 feet, and a length of 28 feet. The heating surface of each boiler is 823 square feet and the grate area 33 square feet, giving a ratio of heating surface to grate area of 24.94-1. Natural draught was employed in both tests. The fuel used was small Welsh coal, and there was no formation of smoke in either test. The draught at the back of the boiler for the stoker trial was 0.35 in., for the hand-fired trial it was not recorded. In the more recent test no attempt was made to press the boilers to their maximum capacity. One boiler only was kept at full power, while the second was regulated to suit the station load. Had the second boiler been brought up to the level of the first, the consumption of coal per square foot of grate per hour could have been raised to 30 lb., and still have shown good efficiency, with the fuel and draught employed. The comparison of the results of the two tests shows a substantial saving in the coal bill for the mechanical method, as the following statement makes clear. With the stokers the extra water evaporated, as from and at 212° Fah. per boiler per cent. was 84.3. The extra water evaporated, as



Alexandra (Newport and South Wales) Docks and Railway Co.

"Bennis" elevators lifting the coal to the shoots through which the fuel passes into the hoppers of the machine stokers. The elevators work in conjunction with the stokers, each is fitted with a rotary feed which renders choking of the buckets by over-supply impossible, and obviates any wrench from the chain.

from and at 212° Fahr. per pound of coal per cent. was 17.5, and the reduction in fuel costs per 10,000 lb. evaporated per cent. was 14.9. These results have been well maintained in actual practice.

THE DEVELOPMENT OF LOGGING MACHINERY.*

By R. E. Boehck.

Operations, generally known as "logging," are those parts of the lumberman's business connected with the cuting of the trees, their transportation and final delivery at the sawmill. They cease to be logging operations after the tree is in the mill, then the work of the millman begins. In the olden days when cities were few and small, there was little need for large lumber corporations such as exist to-day. Most of the lumber was cut by portable mills, in the following manner.

A small sawmill was rigged up in the forest and trees were cut down near the mill in a radius of perhaps a mile and were drawn to the mill by mules or horses. After a clearing was made, the mill would be taken down and moved along to another place about two miles away where it was again set up; these mills were small and their output no larger than the needs of the country demanded. Larger or stationary mills were, with very few exceptions, placed along the banks of rivers, and then a different method for logging was generally employed. The trees were cut and the logs assembled in various places along the river front. When, for instance, a long slope reached down to the water edge, a landing would be built near the bottom of the embankment and then after the slope has been cleared of trees, it would be used as a natural rollway, the logs being slid down to the landing where they were placed in high piles. This appears to be a very simple operation, but in most cases it was very hazardous and dangerous work. In this way the woods were partially cleared. Near the rivers the yield of timber was good, but further inland only the easy accessible places were worked and in different locations no attempt was made to reach the trees. There was little necessity to spend much time by going far from the river's edge, as timber was plentiful in those days. The mills were located near the river on some natural pond or small lake, which was connected with the river by a small canal. The river near the entrance of the canal was usually "dammed" and the logs coming down the river were guided through the canal into the logpond. There they would lie assembled, ready for use in the mill, sometimes several millions of them, comprising a year's work for a mill of average size.

After a while the logging machine made its appearance. It did not, however, change the method of logging for some time. It was used to replace horses and mules and do the work in less time. A portable hoisting engine was employed, provided with one drum. The engine was "anchored" to the ground, that is, fastened to a nearby tree or stump by means of a cable and the wire cable of the drum was drawn into the woods perhaps a thousand feet by several men, there to be fastened to a tree which had been cut down. Then the operator opened the throttle of the engine and the log was drawn toward it. This type of engine was called the "donkey engine"; it is still in use to some extent by smaller concerns, especially on the Pacific Coast.

The next step in advance was the development of a machine to simplify river logging. A powerful drum, driven by steam, was built and placed upon a barge or scow. The drum would hold perhaps a mile of heavy steel cable. The barge was fastened to the river's edge and the rope drawn into the woods. Several tongs were attached to the end of the cable. These machines would draw several logs at a time. This system has the name of pullboat logging. It increased considerably in value when Baptist cones came into use (which are wrought-iron cone-shaped contrivances, named after the inventor, fitted over the tongs on the end of the pulling rope.) As these cones glide easily over any reasonable obstruction in the way, they prevent the breaking of the cable through a blocking of the logs by obstruction.

Soon it became necessary to make such timberland, situated further away from the river, accessible, as the demand for timber became larger. This was done by the introduction of the logging railroad.

With the laying of tracks through the woods, it became necessary to find some way of loading the logs onto cars. This finally was accomplished when a logloader made its appearance. In the beginning this machine was a single drum affair, very simple and slow in its operation. Like most great inventions, it was lacking final perfection and development. It was placed on the side of the tracks. A location was chosen so that it was not more than a few feet away from a suitable tree, which was to serve as a mast. A cable was strung from the mast, at a height of perhaps 30 to 40 feet across the tracks, to the ground and was there fastened to a stump. This cable formed an incline for a pulley which was operated by the drum of the loading engine. Suspended from the pulley was a pair of tongs or slings which served as a means to fasten the log. This having been done, the pulley and log were hoisted upward on the incline until it was over the car. Then it was guided into place by a man on the car. Occasionally it would roll to the ground and the operation had to be gone through once more. In such a case the position of the man on the car was not enviable. A quick jump off the car to the side opposite that of the falling log was usually the only way out of danger.

A decided improvement in logging is the skidder. It bears this name because it drags or skids the logs on the ground toward the railroad. So far all the pulling out into the woods of the empty cable had to be done by hand or animal power. With a train waiting to be loaded and more logs needed by the mill, a way had to be found to do more work with the logging machine. This was finally accomplished by making a two-drum engine, where a larger drum with a heavy cable hauled in the load while a lighter cable on the other drum drew the empty cable into the woods. To accomplish this operation, a pulley is "shackled" to a tree stump, perhaps a thousand feet or more away from the engine. Over this pulley or sheave the lighter cable passes and is then fastened to the end of the hauling-in-cable. When a log is hauled in, the lighter cable travels along, unwinding from the drum until the log reaches the engine, it is stretched out to the pulley over it, and back to the engine again. After the log has been detached, it is wound up on the drum, pulling the heavy cable out toward the pulley. Then another log is attached to the heavy cable and the operation repeated. It can easily be seen that the lighter cable must be twice as long as the hauling cable.

In order to avoid too many logging railroads, very often a skidding machine is placed near the end of the reach of the first skidder cable, not far from the aforesaid pulley. This machine is generally known as the "yarder." Its duty consists of pulling logs to a place where they can be reached by the skidder, which in turn brings them to the railroad. In this way the line of operation can be extended by adding more yarders and the ground can be cleared from two or three miles on each side of the railroad. This is considered

*A paper presented at a meeting of the American Society of Engineer Draftsmen, held on 16th May, 1912, in New York City and St. Louis, Mo.

a good way, as it limits the number of logging tracks, and, of course, those that must be laid can be kept in better condition.

Still another type of logging machine is termed "Roading Engine." It is very similar to the ground skidder but is built for long hauls. It has exceedingly large drums, the main hauling cable being generally about 4,000 feet long. In using this type of engine, it is necessary to build a road for the logs to travel on. This road is mostly built from small trees, which otherwise have little value. A haul of 4,000 feet takes at the very least fifteen minutes. In order to gain time, the outhaul drum is geared up much faster, thus pulling back the empty cable is accomplished in about one-half of the time.

At this stage much had been accomplished and a great deal of heretofore unworkable timberland was opened. But all these machines were of little use in any place where the logs could not be drawn along the ground, like in swamps and over mountains. Some of our best timber, like cypress, spruce and hemlock, grow almost exclusively in swamps, while others, like pine, oak, etc., grow in rugged mountainous regions; therefore, after considerable experimenting, an entirely new method was introduced. Instead of drawing the logs along the ground, they were lifted high and carried clear of any obstructions toward their goal-line. This is done by the cableway skidder, which consists of a cable suspended between two supports, the headspar, part of or near the skidder, and the tailtree in the woods, from 700 to 1,000 feet away. Upon it travels what is termed the skidding carriage. The main cable, after passing over the tailtree, is fastened to a stump and is its own guy, with a similar arrangement on the headspar end of the cable. Provision is also made to take up the sag in the outstretched cable, either by a block and fall or by a separate drum on the engine. Two drums are required for logging, just as in the case of the ground skidder. The carriage is sent out into the woods, and when the desired log is reached it is attached to a pair of tongs or a sling on the end of the inhaul rope, which passes through a sheave wheel on the carriage. The carriage remains stationary, the outhaul rope holding is in place until the log is hoisted to the necessary height. Then the carriage is drawn in and the log is dropped near the skidder, handy for the loading engine to place on the waiting car. An improvement has been made on this type of skidder in late years, by adding a third drum the slackpulling drum, which takes up the unavoidable slack in the in-and-outhaul cable.

The advantages of such a cableway skidder, setting aside the fact that it is the only machine which can be used in swamps or mountains, are quite numerous, as only one headspar is required. With this as a centre, the ground is cleared at a radius from 750 to 1,000 feet, according to ground conditions and size of main cable employed. The tailtree, of course, has to be changed from time to time. As a rule it is more economical to have two main cables; while one is being used, the other is rigged up for the transfer of the carriage. This takes a few minutes and gives the engine operator time to oil the machinery. As soon as this is done, the logging operation may begin on the new line. While work is carried on there, the first main cable, now not in use, is being set up on another tailtree by a gang of men called the "riggers," and this will be ready for use when the logs along the cable which is in use have been removed. This operation is repeated until a circle around the skidding engine has been cleared, after which the machine is moved along to a new setting. In most cases the machine is permanently placed on a heavy steel car, with swinging axles, and on reaching the point where the setting is to be made, it is raised off the tracks by screw hydraulic jacks, then the axles are turned and the whole car placed on a set of temporary tracks at right angles to those of the logging railroad. In this way the skidding car is rolled off the logging tracks, staying parallel with them, but making room for the logging cars to pass. Thereafter the ropes are carried out and preparations are made for hauling the logs.

Another type sets the skidder high on a structure of either steel or wood, which straddles the track and leaves room for logging cars to pass underneath. This is not moved off sideways, as it is not in the way of cars. It is also provided with a set of jacks, generally four, and when it becomes necessary to move to the next setting, it is raised about six inches by means of the jacks, which leaves just enough room for a specially constructed car to run under. Then it is allowed to settle down on the car, the jacks pull up the remaining supports, and the machine is free from the ground, resting entirely on the car, ready to be moved by the locomotive to the next setting.

With all these developments of the skidder, it became important to improve also the loading apparatus. In other words, a loader had to be designed, capable of loading logs as quickly as they were skidded. If these two machines do not balance each other in efficiency and speed, the merits of one is naturally lost through the incompetence of the other, and therefore the loader had to be brought up to the top notch by various improvements. Several styles of loaders, distinctly different from each other, but equally efficient, are now in use. They have a swinging boom for loading, not unlike that of the well-known derrick. One type is built on a turntable, the boom itself does not raise or lower, it merely swings sideways, picks up a log and then swings back again over the track to the desired location, where the log is dropped.

Barring accidents and under average conditions, one of these modern skidding and loading outfits is capable of bringing from 40,000 to 50,000 feet of timber to the mill each day of ten working hours; higher figures have been reached in favorable territory. A sawmill with a daily capacity of 200,000 board feet of lumber would need four or five of these outfits to keep it supplied with logs at all times. The expense is only felt in the initial outlay, the operating expenses of a skidding plant being considerably lower than with any other method employed, and its advantages over other systems are numerous. By far the most important is the following one—it keeps the logs out of the water and therefore it keeps them clean, and clean logs bring with them a great saving in saws. If we realize that a steel band saw costs about $5,000, we understand what that means to the practical business man. By the old way of dumping the logs into a river, some of the best logs, extremely close fibred hard wood, would not float, but sink to the bottom, there to rot, and fortunes have been lost in this way by many lumber companies.

The conditions under which logging operations are carried on, vary greatly, one system may be well adapted for a certain location, but may be a failure elsewhere. The locality must be studied very carefully, and due consideration must be given to the kind and quality of the timber, the density of the trees, the condition and topography of the ground and what difficulties might arise in building a logging railroad; whether trestles have to be erected or rivers bridged. In some cases we may be confronted by a timber average of 2,500 feet per acre, while another may have 25,000 feet for the same amount of ground. It is clear even to the unexperienced that a very quickly and easily portable outfit must be selected to meet the conditions of the first case stated, as the machine will have to be on the go nearly all the time, not much timber being cut in each setting. Then again in mountains we would employ a different method from that

which we would use on level ground or in swampy land. The sawing of lumber is a detail easily arranged for, but the getting of the logs is a problem which requires ingenuity of a different sort. The locomotives must be sufficiently powerful to handle a number of cars, and at the same time not too heavy for the track and grades.

Very recently, in fact only a few months from the date of this writing, the General Electric Company has entered into the logging machine business as a competitor to the manufacturers of the steam engines by building electrically driven apparatus. Already they have installed a few outfits.

MAGNETIC OBSERVATIONS.

The subject of Terrestrial Magnetism has received a great deal of attention within recent years among the civilized countries of the world. Magnetic surveys are being conducted in several countries. The United States have now very complete information over their whole country and are able to publish a fine isogonic map. For some time past we have felt the need of such a map for the district covered by our own work and have received numerous enquiries from others for the same. This office is most advantageously situated to gather this information. Having a large staff of surveyors in the field every year, scattered over a large area, we are able to collect in a short time and at no additional expense a large amount of magnetic information. All surveyors employed by the day are required to take these observations. The magnetic needles now supplied are especially designed for this work and with few exceptions are very sensitive. Through the courtesy of Mr. R. F. Stupart, the director of the Meteorological Service, the compasses are all tested by the officer in charge of the Magnetic Observatory at Agincourt and the index correction determined. Where the needles are found to be anything but first class, a new compass is furnished the surveyor.

In the reduction of the observations to a common epoch we are very much handicapped by the absence of a magnetic observatory in the territory covered by the observations. Two of the staff of this division were placed at widely separated points in the Northwest this past season taking hourly declination readings for a whole month. These observations were afterwards plotted and compared with the daily photographic trace of the declinometer at Agincourt. Investigation of the results appear to show that the reduction of our declination observations by means of the Agincourt records is well worth the trouble, the precision of the resulting declination being apparently increased about two and one-half times. It is realized, however, that this is really not much more than a makeshift, and that what we require for proper reductions are the records of an observatory in the Northwest. This matter is now under consideration by the director of the Meteorological Service, who states that he may possibly be able to establish one there this coming season.

Declination returns for 1910, received to date	987
Previous returns	1,104
Total returns to date	2,091
Declination observations, 1910, for comparison with Agincourt	908
Dip observations, 1910	94
Total force observations, 1910	72

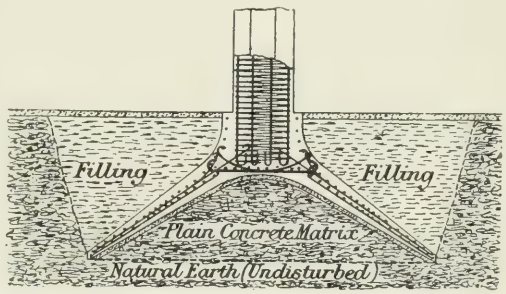
(From the report of the Topographical Surveys Branch, Department of the Interior).

HOLLOW-CONE FOUNDATIONS IN REINFORCED CONCRETE.

A novel method of constructing foundations in reinforced concrete has recently been devised by M. Considère, and described in London Engineering, which, it is claimed, shows considerable economy, both in material and in the cost of construction, over the ordinary methods now in use. The fundamental idea is the formation of a thin cone of reinforced concrete having a base area sufficient to limit the unit load on the ground to whatever figure may be thought desirable, the apex of the cone forming the point of support to the column itself. The amount of excavation for the foundation is also economized, as the earth beneath the cone is not disturbed, but is left roughly in the form of a pyramid. A glance at the illustration will, however, make clear the construction, the method of which is the following:—On the surface of the pyramid formed in the ground a few inches of plain concrete are deposited, and this forms the matrix for the cone of reinforced concrete. The cone is circular in plan, so that the thin covering of concrete has the form of an inverted saucer.

As an example of one of these cone foundations actually completed, one may be selected having on it the exceptionally heavy load of 612 tons in a newly-built boiler-house in France. The allowable pressure on the soil was 5,000 lb. per sq. ft., so that the required base area of the cone was 275 sq. ft., and the diameter 18 ft. 8 in. The angle of the generatrix of the underside of the cone with the horizontal was 30 deg.

It is hardly necessary to say that great care has to be exercised in designing these cones, for the vertical load from the column produces not only a bursting pressure on the cone, which varies in intensity from the apex to the circumference, and which has to be carried by a proper number of circular rings pitched at varying distances, but, in addition to the primary bursting effect, there is a compression varying also in intensity from the apex downwards, to withstand which the concrete must be of sufficient thickness at each point. Adequate concrete and steel must also be provided to prevent the column from perforating the top of the cone by shearing it through vertically. These considerations, however, do not affect the practical construction, which is simple, no temporary shuttering being required.



Sketch Showing Arrangement of Foundation in Place.

It is understood that although the method has been invented and perfected by M. Considère for only a short time, a number of important buildings have already been erected on these foundations, among them being a new dock warehouse at Havre, where the column loads are 195 tons; a boiler-house near Paris, with column loads of 612 tons; and a warehouse at Alexandria, with column loans of from 140 to 180 tons. All the English rights are controlled by the Considère Construction Company, Limited, 5 Victoria Street, Westminster, S.W.

CONSUMPTION OF PULPWOOD.

Over 95 per cent. of Canadian mills cut the pulpwood used by them from their own limits and consequently ross the wood themselves. Hence the given pulpwood consumption refers only to wood manufactured into pulp in Canadian mills, and includes only wood of domestic origin. There are seventeen mills on the lists of the Forestry Branch of the Department of the Interior from which no returns were received in 1910, but in nearly all cases these firms are newly incorporated or are known to be shut down, either temporarily or permanently. The quantity and value of the pulpwood industry, as compiled by Mr. H. R. Macmillan, may be considered a trustworthy estimate.

The fifty-one mills reporting used, in 1910, 598,487 cords of wood. There were exported in a raw state 943,141 cords, and for the first time pulpwood was imported into Canada to the extent of $49,322.

Although 23,642 cords of wood, or 3.8 per cent., less was used in 1910 than the year previous, the average price per cord has increased the value of the pulpwood industry by $121,074 over its value in 1909. The decrease in the quantity is due to the temporary closing of one or two large mills. This year the price of pulpwood recovered from the decline seen in 1909, when the price was only $5.57 per cord, and is about the same as in the year previous. The price was $6.07 in 1908 and in 1910 was $6. In 1910, also, 29,196 more tons of pulp were produced than during 1909, owing to an increase this year of some 145 lbs. in the amount of pulp produced per cord of wood.

Quebec is the premier pulpwood province of Canada because of its extensive spruce and balsam fir forests suitable for pulpwood, abundant and cheap water-power and plentiful supply of labor. The twenty-five mills in Quebec reported the consumption of 57 per cent. of the total for Canada, or 22,820 cords more than in 1909. Ontario likewise increased the amount consumed in its fifteen pulp mills by 23,200 cords, and used over one-third of the total consumption. The two provinces just named furnished over 92 per cent. of the total quantity of pulp. Nova Scotia consumed nearly 20 per cent. more than last year, while New Brunswick used barely one-fifth as much as in 1909. Thus Nova Scotia surpasses New Brunswick as a pulpwood province. New Brunswick in 1909 contributed 14.2 per cent. of the total; this year it was only 2.2 per cent.; this resulted mainly from the closing of one large plant. The province of British Columbia is still experimenting in pulpwood manufacture, and the negligible amount used in this province is for test purposes only.

Quebec is the one province in which the price of pulpwood was less in 1910 than 1909, the price falling off 35 cents per cord. The increase in the price of pulpwood throughout Canada is largely due to Ontario, in which province pulpwood was worth $7.02 per cord, or $1.30 more than during the previous year. Pulpwood was also more expensive this year in Nova Scotia and New Brunswick. Pulpwood from Nova Scotia, at $4.59 per cord, was cheaper than in any other province.

The decrease in the amount of pulpwood used in 1910 chiefly affected the use of spruce—45,800 cords less of this species being used in 1910 than in 1909. Although still over 75 per cent of the total pulpwood consumption, the proportion is gradually becoming less. In 1908 spruce formed 87 per cent. of the total, in 1909 83 per cent., and in 1910 78.6 per cent. The loss is all seen in New Brunswick, in which province 71,000 cords less of spruce was used this year than in 1909.

Balsam fir is a species of wood which is increasing in importance as a pulpwood. In 1910 twenty per cent., or 20,380 cords, more balsam fir was used than in 1909, and it is steadily gaining for itself a higher position among the important pulpwood species. In 1908 it formed 12 per cent. of the total, in 1909 16 per cent., and in 1910 20 per cent.

Another species which is gradually but surely becoming more important is hemlock, over five times as much being used in 1910 as during 1909. Hemlock was reported as a pulpwood for the first time in 1909, and this year it was used to a greater extent than poplar, thus becoming the third species in importance among pulpwoods.

The use of poplar fell off one-quarter, as only 3,608 cords of this wood were used in 1910. Jack pine has not been reported as a pulpwood since 1908. Before that time it was used considerably by two large mills, but has proven unsatisfactory.

The average price of the different species used is the cost to the mill-owner, and so includes varying logging expenses and a wide difference in transportation charges. A considerable proportion of the pulp-mill owners have their own timber limits, and to them the cost of pulp logs is merely the cost of carrying the limit and the transportation charges. Other operators buy in the open market and add transportation charges also.

Thus the prices quoted are the purchase price under different conditions and do not show the relative value of the different woods for pulp manufacture.

The effect of an excessive hauling distance is demonstrated in Ontario, where the price of spruce and balsam fir in 1910 was $7.01 and $7.22 respectively. The high price of balsam fir and the increased demand for this species proves its suitability for manufacture into pulpwood. Spruce was the most expensive species at $6.05, or 64 cents more than in 1909. During 1910 the price of balsam fir fell to the amount of 55 cents, to $5.71. Hemlock remained at about the same price for the two years and is still the cheapest species. In 1909 it was $4.51, and in 1910 $4.43. Poplar has increased 11 cents during the year, the price being $5.92 during 1910. The cheapest pulpwood bought was a small quantity of poplar in Nova Scotia, which cost $3 per cord. Balsam fir in Ontario at $7.22 was the most expensive wood used in Canada for pulping.

During 1910, no slabs nor sawmill waste was reported as being converted in woodpulp. This is an economy practiced in other countries, and by neglecting it Canada is losing greatly. It has been conservatively estimated that if all useful logs left in the bush by lumbermen, large-sized branches, slabs and other mill waste from the lumber industry in Canada had been conserved and converted into pulpwood in 1910, the annual output of pulpwood would have been increased, and not a single acre need have been cut over for logs to make wood-pulp only. During 1909, in the United States, 6 per cent. of the total pulpwood consumption was from slabs and mill waste. If economy had been practiced to the same extent in Canada during the year 1910, as much pulp might have been produced without cutting one additional pulp log as is manufactured from 36,000 cords of wood. This is considerably more pulp than Nova Scotia produced during 1910. The sooner such practical economy and utilization of waste commences, the longer will Canada have an adequate supply of pulpwood.

A PECULIAR ACCIDENT.

It is seldom that a steam engine fails to obey the action of the throttle, yet such was the fate of the steamer "Mildred" which, while approaching the lock gates of the canal at Buckingham, Que., became unmanageable and went over the dam. The water flooded the steamer, the boilers exploded and a cargo of cement was lost.

THE INTERNATIONAL ROADS CONGRESS OF 1913.

The third International Roads Congress will be held in London from Monday, June the 23rd to Saturday, June the 28th, 1913. These congresses will in future be held triennially. The first was held in Paris in 1908, and the second in Brussels in 1910. Their object is to collect, discuss, and circulate all the latest practical and scientific knowledge with regard to the construction and maintenance of highways. The congress of 1913 is held on the invitation of the British Government and is under the patronage of His Majesty King George V. The honorary presidents of the congress are the Right Hon. the Chancellor of the Exchequer and other members of H.M. Government, and the vice-presidents include the Right Hon. the Lord Mayor of London; members of both Houses of Parliament; Chairmen of County Councils; Mayors of Cities and Boroughs; presidents of learned societies, and of associations of local authorities, engineers, automobilists, cyclists, and of other organizations interested in the improvement of the roads. Over thirty Governments have intimated to the British Minister of Foreign Affairs their intention of taking part officially in the congress.

In view of the great advance effected in the methods of road construction and maintenance in recent years by the extension of the use of bituminous binding material, and the numerous experiments that have been made and data accumulated since the last congress, there is no doubt that the discussion of the various questions to be submitted to the congress will make the London meeting a notable event in the history of road engineering.

The two previous congresses aroused great interest among engineers, surveyors, automobilists, and manufacturers of road-making materials throughout the world, and a number of very valuable papers were contributed by the world's leading authorities on various subjects connected with the construction of roads.

Having regard to the rapid development of road construction in Canada these congresses cannot fail to prove of very great benefit and interest to those responsible for the good condition of the public highways in this country, and it is to be hoped that in view of the numerous opportunities for inspection of works and sites in England the number of Canadian delegates and members of the congress will be large.

The congress of next year will receive and consider a number of papers and reports by the leading authorities throughout the world on the maintenance of roads, their foundations and proper drainage, the prevention of dust and mud, the laying of light railways and tramways on roads, the choice of surfacing materials, the influence of weight and speed of vehicles on roads and bridges, the conditions that should be filled by horse or mechanically propelled vehicles in order that they may not damage or suffer damage from the roads, etc.

The chairman of the local Organizing Committee is Sir George S. Gibb, chairman of the Imperial Road Board. Sir Charles D. Rose, Bart., M.P., is treasurer, and Mr. W. Rees Jeffreys (secretary of the Road Board) is honorary secretary.

Excursions have been planned to various places of interest, including Windsor Castle, where His Majesty the King has intimated his intention of entertaining the delegates to afternoon tea. Receptions will be given to the members of the congress by the Lord Mayor and Corporation of the City of London at the Guildhall, by the committee of the Royal Automobile Club in their palatial premises in Pall Mall, and by the Institution of Civil Engineers in their new premises which they are now building at Westminster.

An exhibition of road machinery, materials and appliances used in road construction is being organized in connection with the congress, and in view of the fact that a very large attendance of foreign delegates is expected, in addition to engineers and surveyors from all parts of the United Kingdom, the exhibition will, it is expected, prove of great practical commercial value.

Membership of the congress is open to all, the individual membership subscription being £1, and that for associate members, i.e., wives and children, is 8/4.

Either of these subscriptions entitles the member to take part in all excursions and entertainments connected with the congress, whilst the full membership subscription entitles the subscriber, in addition to taking part in the proceedings of the congress, to receive the daily agenda published during the congress and a copy of the full report of the discussions and decisions, in addition to the complete set of the various papers on different subjects sent in by the members. As these papers comprise reports by leading authorities in all parts of the world, of experiments and recent data obtained in road engineering, etc., they are therefore of the highest value and interest.

Mr. W. Rees Jeffreys, the honorary secretary, is now in America endeavoring to secure a large attendance of engineers from this side. He arrived in New York on June 4th, and after spending a couple of weeks in the principal cities of the United States, will arrive in Toronto on June 27th. While in Canada he will visit Niagara Falls, Ottawa, Montreal and Quebec.

ENGINEERING OPPORTUNITY IN CHINA.

Rev Dr. T. E. Egerton Shore has received a cablegram from Dr. O. L. Kilborn in Chengtu, China, capital of the province of Szechwan, west China, asking that a teacher in mining engineering be secured for the Chinese Government School in Chengtu. This teacher will be supported by the Provincial Government at a salary of $2,100 (gold), together with traveling expenses each way—the salary to date from the time of arrival in Chengtu and the contract to be for a period of one year, with the probability of its extension beyond that time.

The cablegram states that this teacher is required at once and that a splendid opportunity presents itself from the standpoint of Christian influence in a government institute.

Dr. Shore will be glad to hear from anyone who may be interested in this opportunity. His address is the Methodist Mission Rooms, 33 Richmond Street West, Toronto.

THE LJUNGSTROM STEAM TURBINE.

The Ljungström turbine is the latest development in the field of steam turbines of the reaction type. As described in Engineering of London, it consists essentially of a radial flow machine. The steam is admitted between two disks, and in its passage from the centre to the circumference it passes between concentric blading rings carried alternately by the two disks. In the usual design both disks revolve, driving their shafts at equal speeds. To each shaft is coupled an electric generator. Since the relative speed of the blade is twice as great as in the standard reaction turbine of equal diameter and peripheral speed, equal efficiency may be obtained with only one-quarter as many rows of blades. Since there is no long casing with fixed blading, the risk of distortion trouble is largely eliminated. This also permits an almost unlimited degree of superheat, which, together with the reduction of gland and other losses, tends to give the machine a high efficiency.

PERSONAL.

MR. J. RUSSELL ELLIS has been appointed to the position of assistant engineer for the municipality of Regina.

MR. S. D. EGAN, of Toronto, has been appointed to the position of superintendent of the municipal railway system of Regina.

MR. W. H. ELSON has been appointed superintendent of two of the interurban divisions of the British Columbia Electric Railway, Limited, Vancouver, B.C.

MR. J. B. RANNIE has been appointed traffic agent of the British Columbia Electric Railway, Limited, Vancouver, B.C., in charge of the company's system in Vancouver and suburbs.

MR. ALLAN PURVIS has been appointed manager of the interurban lines of the British Columbia Electric Railway, Limited, Vancouver, B.C. The position of local manager of interurban divisions has been abolished.

COMING MEETINGS.

AMERICAN WATER WORKS ASSOCIATION.—June 3rd 8th. Annual Convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N.Y.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithica, N.Y.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President, J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close — Noted in issue of

6-10—Electrical equipment, Vernon, B.C. .....(S.) 5-16
6-17—Electric Generating Station Equipment, Bassano, Alta. .....(S.) 5-30
6-10—Cement sidewalks, Maple Creek, Sask.(P & S.). 5-30

(Vernon specifications are on file at The Canadian Engineer Offices, Winnipeg and Montreal; Mather, Yuill & Company, Limited, Consulting Engineers, Vancouver, B.C.)

(Bassano specifications also on file at the office of The Canadian Engineer, Montreal, and the Engineers, Messrs. Bowring & Logan, 322 Donald St., Winnipeg).

(Maple Creek plans and specifications on file at The Canadian Engineer Office, Winnipeg, Man.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Bassano, Alta., electric generating machinery	June 17.	May 30.	74
Berlin, Ont., waterworks improvements		May 23.	72
Edmonton, Alta., pile wharf	June 17.	May 23.	60
Fredericton, N.B., wharf	June 6.	May 16.	60
Lethbridge, Alta., paving	June 14.	May 30.	61
Moose Jaw, Sask., light standards	June 14.	May 30.	62
Moose Jaw, Sask., retaining wall and sidewalks, Collegiate Institute	June 5.	May 16.	60
Maple Creek, Sask., sidewalks	June 10.	May 30.	74
Newmarket, Ont., school building	June 15.	May 30.	62
Oshawa, Ont., concrete sidewalks	June 8.	May 30.	72
Ottawa, Ont., station and other buildings	June 14.	May 30.	72
Ottawa, Ont., dredging Murray Canal	June 5.	May 30.	62
Ottawa, Ont., coaling stations	May 31.	May 9.	72
Ottawa, Ont., mail contract	June 21.	May 23.	76
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., fishing protection vessel	June 17.	Apr. 18.	74
Ottawa, Ont., design and construction of steamship	June 30.	May 16.	76
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Quebec, Que., leasing of water-powers	June 26.	May 2.	72
Saskatoon, Sask., garbage incinerator	June 25.	May 2.	74
St. Catharines, Ont., S. S. building	June 10.	June 30.	62
Toronto, Ont., cribs; retaining wall	June 5.	May 30.	74
Toronto, Ont., bridge construction	June 8.	May 30.	74
Toronto, Ont., concrete abutments	June 8.	May 30.	74
Tisdale, Sask., storm water sewers	June 15.	May 30.	62
Toronto, Ont., bridge construction	June 6.	May 23.	72
Toronto, Ont., concrete abutments	June 5.	May 23.	72
Toronto, Ont., concrete breakwater	June 6.	May 23.	72
Vancouver, B.C., bridge construction	July 8.	May 30.	74
Vernon, B.C., electrical equipment	June 10.	May 16.	72
Vernon, B.C., cast-iron pipe	June 10.	May 23.	60
Vernon, B.C., valves and hydrants	June 10.	May 23.	60

TENDERS.

Battleford, Sask.—Tenders for the installation of a steam heating system for the Battleford Town Hall, will be received up to noon of June 10th, 1912. Plans and specifications can be seen at the Builders' Exchange, Winnipeg and Saskatoon, and at the office of J. P. Marshall, secretary-treasurer, Battleford.

Brantford, Ont.—Tenders will be received until noon of June 15th, 1912, for the furnishing of about 6,000 feet of reinforced concrete sewer pipe, varying in size from 30 inches to 45 inches. Specifications may be seen at the office of the City Engineer. T. Harry Jones, City Engineer, Brantford. (See advt. in The Canadian Engineer).

Kerrisdale, B.C.—Tenders for the supply of about 8 miles of steel pipes, varying in diameter from 4 to 18 inches, will be received until June 24th, 1912, by H. Floyd, Clerk Municipal Council, Kerrisdale, B.C. Particulars may be obtained at the office of the engineers, Cleveland and Cameron, 506 Winch Building, Vancouver.

Lachute, Que.—Tenders for the construction of an iron bridge over the North River, in the parish of St. Jerusalem, County of Argenteuil, will be received until June 10th, 1912. Plans and specifications can be examined in the office of J. E. Valois, secretary-treasurer, municipality of the council of the parish of St. Jerusalem, Lachute, Que.

Lawrenceville, Que.—Tenders for the construction of an iron bridge over the black river in the village of Lawrenceville, Que., will be received until the 15th of June, 1912. Plans and specifications can be examined at the office of Zoel Gervais, secretary-treasurer. municipality of village of Lawrenceville, Que., at which place tenders will be received.

Ottawa, Ont.—Tenders will be received up to noon of July 3rd, 1912, for the purchase of the Canadian Government steamer "Kestrel." Full particulars may be obtained from the Officer in Charge, H.M.C. Dockyard, Esquimalt, B.C. G. J. Desbarats, Deputy-Minister, Department of the Naval Service, Ottawa. (See advt. in The Canadian Engineer).

Ottawa, Ont.—Tenders for the construction of a public building at Kemptville, Ont., will be received at the Department of Public Works, Ottawa, until June 13th, 1912. Plans, etc., can be obtained at the post office, Kemptville, and at the Department, R. C. Desrochers, secretary.

Ottawa, Ont.—Tenders for the construction of a post office building at Maisonneuve, Que., will be received at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa, until Monday, June 17th, 1912. Plans, etc., may be obtained on application at the office of Mr. C. A. Reeves, architect, 58 St. James Street, Montreal, and at the post office, Maisonneuve; also at the Department of Public Works, Ottawa.

Ottawa, Ont.—The Department of Public Works, Ottawa, will receive tenders until June 5th, 1912, for interior fittings, post office, Mount Forest, Ont. Plans, etc., to be seen on application to Mr. J. Hunter, Clerk of Works, Mount Forest, Ont.; Mr. T. A. Hastings, Clerk of Works, Postal Station F, Toronto, and at the Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received up till noon of Wednesday, July 17th, 1912, for industrial sites situate on an island lying east of the village of Caughnawaga, and joined to the mainland by the embankment of the Canadian Pacific Railway, and adjacent to the city of Montreal, containing 61.4 acres. Full information may be obtained upon application to Lorenzo Letournear, Assistant Indian Agent, St. Constant, Que., or to J. D. McLean, Assistant Deputy and Secretary, Department of Indian Affairs, Ottawa.

Ottawa, Ont.—Tenders for dredging required at Yarmouth, in the Province of Nova Scotia, will be received up to June 13th, by R. C. Desrochers, Secretary, Department of Public Works, Ottawa. Specifications can be obtained on application to the secretary.

Ottawa, Ont.—Tenders for the construction of a breakwater wharf at Carr's Brook, Colchester County, N.S., will be received by the Secretary of the Department of Public Works, Ottawa, until June 27th, 1912. Plans, etc., can be obtained at the Department and at the offices of H. A. Russell, Esq., District Engineer, Halifax, N.S.; E. G. Millidge, Esq., District Engineer, Antigonish, N.S., and on application to the Postmaster at Carr's Brook, N.S.

Ottawa, Ont.—Tenders for the construction of a pile bent wharf at Boswell, Division of Nelson, Kootenay District, B.C., will be received until July 2nd, 1912. Plans, etc., at the offices of G. A. Keefer, Esq., District Engineer, New Westminster, B.C.; on application to the Postmaster at Victoria, B.C., and the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the construction of a drill hall at Gananoque, Ont., will be received by the Director of Contracts, Department of Militia and Defence, Ottawa, up to noon of June 22nd, 1912. Full particulars may be obtained at the offices of the Officer Commanding the 8th Field Battery, Gananoque, Ont.; the Officer Commanding the 3rd Division, Kingston, Ont., and the Director of Engineer Services, Department of Militia and Defence, Ottawa.

Port Arthur, Ont.—Tenders for paving on Cumberland and Algoma Streets will be received until June 24th, 1912. Further information, as to plans, etc., may be obtained from the City Engineer. J. J. Hackney, Commissioner Utilities, Corporation Offices, Port Arthur. (See advt. in The Canadian Engineer).

Regina, Sask.—Tenders will be received until noon of June 14th, 1912, for the supply of about 350 tons of reinforcing steed bars, 145 tons of R. I. joists, 6,000 barrels of Portland cement, and castings for the proposed Torhill Reservoir. Plans, etc., may be obtained from R. O. Wynne-Roberts, Consulting Engineer, Regina. (See advt. in The Canadian Engineer).

Regina, Sask.—Tenders for the construction of Torhill reinforced concrete circular reservoir and for works incidental thereto, will be received up to noon of June 21st, 1912. Plans, etc., may be obtained from R. O. Wynne-Roberts, Consulting Engineer, Regina. (See advt. in The Canadian Engineer).

Regina, Sask.—Tenders will be received up to June 15th, 1912, for the erection of a four-room brick school building at Buchanan, Sask. Plans may be secured from Messrs. Storey and Van Egmond, architects, Regina; and from H. P. Albert Hermanson, secretary-treasurer, Buchanan School District, Sask.

St. Thomas, Ont.—Tenders for the construction of sewers and for the supply of sewer pipe, will be received until June 19th, 1912. Specifications and plans can be seen at the office of the City Engineer. (See advt. in The Canadian Engineer).

Toronto, Ont.—Tenders for the terra cotta work, fireproofing and roofing of the new Government House, Chorley Park, Rosedale, Toronto, will be received up to noon of Monday, June 10th, 1912. Plans and specifications can be seen at the Department of Public Works, Toronto. H. F. McNaughten, secretary.

Toronto, Ont.—Tenders for steam heating, etc., in connection with the main drainage pumping station will be received up to noon of Tuesday, June 18th, 1912. Plans and specifications may be seen at the office of the City Architect, City Hall, Toronto. G. R. Geary, (Mayor), Chairman Board of Control, City Hall, Toronto.

Vancouver, B.C.—Tenders for the supply of the following pipe will be received until June 12th, 1912:—

10,000 ft. 24-in. inside measurement, steel pipe, 3-16 plate.
30,000 ft. 24-in. inside measurement, steel pipe, ¼ plate.
10,000 ft. 24-in. inside measurement, steel pipe, 5-16 plate.
4,000 ft. 18-in. inside measurement, flexible joint cast-iron pipe.

Plans and specifications can be obtained at the office of Messrs. Hermon & Burwell, Rm. 12, Inns. of Court, or at the office of James Stuart, Esq., City Purchasing Agent, City Hall, Vancouver.

Vancouver, B.C.—Tenders for the supply of 10,000 feet of 24-in. steel pipe and 4,000 feet of 18-in. flexible joint C.I. pipe will be received up to noon of June 12th, 1912, by James Stuart, City Purchasing Agent. Plans and specifications to be seen at the office of Messrs .Hermon & Burwell, Inns. of Court Building.

Victoria, B.C.—Tenders for the erection and completion of a large one-room schoolhouse at Diamond Crossing, in the Newcastle Electoral District, B.C., will be received up to noon of June 12th, 1912. J. E. Griffith, Public Works Engineer, Department of Public Works, Victoria.

Winnipeg, Man.—Tenders will be received up to noon of June 10th, 1912, for the construction of a Normal School in the city of Brandon. Plans, etc., may be seen at the office of the Provincial Architect, 261 Fort Street, Winnipeg, or on application to W. H. Shillinglaw, Esq., Brandon. R. P. Roblin, Acting Minister of Public Works, Winnipeg.

CONTRACTS AWARDED.

Brandon, Man.—Messrs. Geo. H. Archibald Co., Ltd., Winnipeg, are the contractors for the rebuilding of the Maple Leaf Milling Company's elevator, which was destroyed a short time ago by fire. The elevator will have a capacity of 120,000 bushels.

Calgary, Alta.—Contracts have been awarded for six new schools to be built in the city, the total cost of which will be $335,500. The following are the names of the builders to which each particular contract has been awarded: Sunalta school awarded to Doyle and Thomas, to cost $124,000; school on the Ramsey estate to T. R. Yeager, to cost $124,000; addition to the Victoria to J. A. McPhail, $63,000; Park Hill, J. A. McPhail, $15,500; two cottage schools awarded to H. Lougheed and H. Church, respectively.

Edmonds, B.C.—The contract for the extension to the high level reservoir on Capitol Hill, from which the entire water supply of the municipality is to be drawn, was awarded to Messrs. A. L. Olts & Co., of Vancouver, at $11,045.92; and the contract for the low level reservoir in D. L. 158, to supply River Road and South Burnaby generally, was let to G. H. Webster, of Vancouver, at $13,062.50.

Fredericton, N.B.—The Messrs. McVay have received the contract for the construction of an arch culvert over Lane's Creek, Carleton County. They have also secured the contract for the building of a new school building of concrete blocks at St. Andrews, the contract price being about $25,000.

Fredericton, N.B.—Contracts were awarded by the Quebec Contracting Company to sub-contractors for twenty-one miles of the work on the Saint John Valley Railway between Fredericton and Woodstock. The contracts are for the clearing, grubbing and grading, and are awarded as follows:—

To L. B. Smith and E. L. Merrithew, from mile 7 to 16½.
To Collins, Labelle & Prey, from mile 16½ to 20.
To W. and C. R. MacDonald, from mile 27 to 32.
To J. A. Wheaton & Son, St. John, from mile 32 to 35.

The contract for the construction of the fencing and telegraph lines between Fredericton and Woodstock has been awarded to T. R. Campbell, of Salisbury.

Fredericton, N.B.—Contracts for the construction and equipment of the Palmer-McLellan Shoepack Company's plant have been signed and calls for the expenditure of about $35,000. The John Palmer Company are also commencing operations for the construction of their new plant near the Hartt Boot & Shoe Company's factory.

Kerrisdale, B.C.—The Kerrisdale and Magee districts sewerage contracts has been awarded to Messrs. McLean & Co., at $156,000.

Barrett Specification Roofs

On the "Concrete City."

IN the illustration below, the Turner Construction Company of New York, has brought together in a scale drawing an accurate representation of most of the important modern concrete buildings which they have erected during the past nine years, at an approximate cost of $12,000,000.

It is an imposing display of best types of modern construction—"*a concrete city*" indeed—scientifically designed for maximum service at minimum cost and minimum maintenance.

It is significant that 95 per cent. of the entire roof area is covered with the Barrett Specification type of roofing. The figures are as follows:

Barrett Specification type of roofs	1,490,523 sq. feet
Plastic Roofings	14,714 sq. feet
Slate Roofings	21,640 sq. feet
Tile Roofings	5,619 sq. feet
Ready Roofings	38,381 sq. feet
Copper Roofings	6,355 sq. feet
All other kinds	7,448 sq. feet

It is important to remember that while all these buildings were constructed by the Turner Construction Company, the specifications were drawn by a large number of architects and engineers.

Barrett Specification Roofs were almost unanimously selected for one reason only, namely that they would give *better* service at *lower cost*, than any other roof covering.

Barrett Specification Roofs require no painting or similar attention—in other words, there are no maintenance costs. They will last upwards of 20 years without any care.

The superior economy of Barrett Specification Roofs justifies their adoption not only on big first-class concrete buildings, but on every flat roofed building from a tenement to a skyscraper—from a small mill to a modern manufacturing plant costing millions. But be sure it's a real Barrett Specification Roof. The only way to be sure is to incorporate The Barrett Specification in full in your plans.

Copy of The Barrett Specification free on request. Address our nearest office.

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MONTREAL TORONTO WINNIPEG VANCOUVER ST. JOHN, N.B. HALIFAX, N.S.

Kincardine, Ont.—At a meeting of the County Road and Bridge Committee at Port Elgin, it was decided to award the contract for the reconstruction of the Denny's Bridge to Messrs. Hunter Bridge & Boiler Company, of Kincardine, their price being $7,800.

Newcastle, N.B.—The contract for the construction of the new Court House has been awarded to Messrs. John McDonald and Henry Ingraham, whose joint tenders was for $31,000, which includes wiring and plumbing.

Stratford, Ont.—The Stratford Bridge and Iron Company have been awarded the contract by the County Councils of Wellington and Grey, for the steel work of O'Dwyer's bridge at $1,875.

Toronto, Ont.—Messrs. J. E. Webb Co., General Contractors, Fisher Street, Toronto, have been awarded the contract for the building of the St. Lawrence Starch Factory at Port Credit. Main building is 480 x 100; five stories; brick stack, 150 ft. high; size inside of flue is 8 ft. square. The materials used are brick, concrete and steel.

Vancouver, B.C.—Messrs. Waterhouse, Church & Kerr, New York, have secured the contract for building the new Canadian Pacific Railway depot at Vancouver. It will cost $1,400,000. The company will also build a tunnel in the downtown section to relieve the conjestion of traffic. Railway crossings will be abolished and overhead bridges built, the whole involving a total of several million dollars.

Vancouver, B.C.—The Canadian Pacific Railway has awarded to Culletin Bros., of Spokane, a contract for the construction of ten miles of the east coast division of the E. & N. Railway, on Vancouver Island. Their work will extend north from McBride Junction near Nanaimo. Another ten-mile section from Courtenay south, in the direction of Campbell River, was recently let to Mr. C. E. Hoard, of Victoria. Between this contract and the Culletin work is a gap of sixty miles, the construction of which will likely be undertaken later in the year.

Vancouver, B.C.—Messrs. Kelling & Co., have been awarded the contract for heating four schools in this city, the tender submitted being $26,500.

Vernon, B.C.—The contract for the construction of approximately 50,000 feet of combined sidewalk and curb, has been awarded to Messrs. B. C. Craintoid, Ltd., of Vancouver, for $13,394.50.

Walkerton, Ont.—The Saugeen Electric Light and Power Company, and the Walkerton Light and Power Company, have awarded the contracts for the repairs on the Southampton dam, and also on the one at Walkerton, both of which were put out of commission by the spring floods. The weir at Southampton is to be completed in ten weeks, and the one here within three months. The owners of both dams are Messrs. Robertson and Roland, of Walkerton. The probable loss at Walkerton is about $10,000, and at Southampton $5,000.

RAILWAYS—STEAM AND ELECTRIC.

Saskatoon, Sask.—The municipal council have decided to present a by-law calling for the construction of a street railway to the ratepayers for decision. The Stone and Webster Engineering Corporation have made an offer to construct the line and finance the same for the period of twelve months in exchange for civic bonds to the value of $500,000.

LIGHT, HEAT AND POWER

Barrie, Ont.—The ratepayers voted in favor of the hydro-electric by-law which called for an expenditure of $7,000.

Kingston, Ont.—Mr. R. S. Kelch, of Montreal, is preparing a report for the municipal council on the power question, and will have the same ready for presentation in the course of a few days.

Moose Jaw, Sask.—The city of Moose Jaw has accepted the proferred assistance of Saskatoon, and the council have asked for the plans of Saskatoon's new power house. R. M. Thompson, who was responsible for the plans of the new building, will go into the matter there with the city council of Moose Jaw. Meantime with the assistance of machinery supplied by the Robin Hood Milling Co., of that city, a limited amount of power is being obtained to give the city a partial water supply, and to care for the absolute necessities requiring electrical power. It is understood that the city will go ahead at once with the construction of a new power plant.

Scotstown, P.Q.—The power plant of this municipality was swept away when a dam belonging to the Emberton Lumber Company gave way.

GARBAGE, SEWAGE AND WATER.

Berlin, Ont.—The ratepayers will be asked to vote on a proposed expenditure of $100,000 on a new sewage system. Mr. Peiper is chairman of the Municipal Sewage Committee.

Exeter, Ont.—The ratepayers voted in favor of spending the sum of $5,000 for improvements of the sewage system.

Fort William, Ont.—Mr. T. Aird Murray has recommended that a new 24-inch main be constructed immediately to the reservoir. The cost of this will be about $75,000. Other improvements to the water supply which he has suggested will cause an expenditure of about $350,000 if carried out as he has planned.

Moose Jaw, Sask.—A large pump, the property of the Saskatchewan Flour Mills, has been installed in the pit of the old power plant and is giving a satisfactory service. The supply is being taken from the Moose Jaw River and forced through the filter beds before entering the mains.

Simcoe, Ont.—The ratepayers voted their approval to the expenditure of $36,000 for a sewage system.

Vancouver, B.C.—The Municipal Board of Works received tenders for the construction of lateral sewers on Twelfth, Thirteenth, Fourteenth and Fifteenth in the vicinity of Oak and Yukon Streets, as follows:—

Romano Pinto & Co.	$31,500.00
LaPlaca Brothers	22,479.00
Ledingham & Cooper	32,746.00
McGarry Company	29,000.00
Kennedy Brothers	28,849.00
D. A. Anderson	22,778.95
David Timiro	21,097.80
Bruce & Ford	39,900.00

The tenders were all referred to the City Engineer for report.

BUILDINGS AND INDUSTRIAL WORKS.

Calgary, Alta.—Applications for the erection of three apartment houses are being considered by the municipal architect. The owners of the buildings are Mr. George Calhoun, Mr. J. W. Dafoe, and Messrs. Scott and Hartfront. The total cost of these buildings will be about $140,000.

Creston, B.C.—The Canyon City Lumber are making arrangements for a plant to manufacture small fruit boxes. Mr. D. W. Briggs, of Portland, Oregon, is president of this company.

Fort William, Ont.—The management of the Benson Starch Works of Edwardsburg, are considering the erection of a plant on Island No. 2 near this city.

Fort William, Ont.—The management of the Great Wire Fence Company of Winnipeg, have opened negotiations with the Industrial Bureau that may end in the erection of a plant in this city.

Hamilton, Ont.—The Steel Castings Syndicate will erect a $300,000 plant in this city. C. W. Sherman, of Buffalo, N.Y., is the manager of this new concern.

Lethbridge, Alta.—Messrs. C. Roy Strotz & Company, of Winnipeg, have had preliminary work commenced in the matter of erecting a factory in this city.

Moose Jaw, Sask.—The plans of the proposed Young Women's Christian Association Building, show a four-story building of brick and stone.

Port Arthur, Ont.—A report states that certain interests are making preparation for the erection of a ten-story office building.

Saskatoon, Sask.—The management of the Queen's Hotel have had plans prepared for alterations which will make their building five stories in height.

Sherbrooke, Que.—The Jenckes Machine Company have decided to enlarge their plant. The additions consist of a ma-

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RESERVOIR TANKS

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chine shop, 300 x 50 ft., and a boiler shop 300 x 60 ft. It was announced some time ago that one new shop would be built, but the company has now decided to build two shops.

Stratford, Ont.—The management of the R. M. Ballantyne Company have approved plans which will enlarge the present factory to double capacity.

Toronto, Ont.—Messrs. H. P. Eckardt & Co. will erect a six story warehouse at a cost of $75,000.

Toronto, Ont.—There is a probability of the congregation of the Kew Beach Presbyterian Church erecting a new church building or enlarging the present structure.

Waterloo, Ont.—The ratepayers voted in favor of a by-law granting a loan of $10,000 to Chas. Kreutzger, for the erection of a box factory.

Welland, Ont.—The management of the Welland Machine & Foundries are preparing plans for an enlargement of their plant.

Welland, Ont.—Plans are prepared for extensive additions to the Page Hersey pipe mills, consisting of a large addition to the tube plant and the construction of a pattern shop and a pattern storage building.

West Toronto, Ont.—The management of the Russell Motor Car Company have had plans prepared for the erection of a four story machine shop, 170 x 60. The cost of this work is estimated at $100,000.

West Toronto, Ont.—The management of the Canada Foundry are erecting a plant for the manufacture of ornamental iron work.

Weyburn, Sask.—The Saskatchewan Creamery Company has had plans prepared for the erection of their plant.

BRIDGES, ROADS AND PAVEMENTS.

Barrie, Ont.—The ratepayers voted in favor of spending the sum of $25,000 on the construction of permanent roadways.

Greenfield Park, P.Q.—The council of this municipality, which is near Montreal, will co-operate with the parish of Longueuil in the construction of a permanent highway under the Good Roads Act.

Ottawa, Ont.—The Deputy-Minister of Railways and Canals, Mr. A. W. Campbell, has suggested that the Ottawa East bridge be removed, should a new structure be erected across the canal.

Trail, B.C.—The new steel bridge erected across the Columbia River at this point has been finished, and is now open to the public. This bridge is a portion of the highway now being constructed to Christina Lake, and when this is completed a very fine scenic district will be open to tourists.

Vancouver, B.C.—The Board of Works received tenders for street paving as follows: wood block pavement on Cambie Street, Robson to Smythe:—

Romano Pinto & Co.	$7,900
LaPlaca Brothers	7,867
B. C. Granitoid Company	8,113
McAdam Construction Company	7,400
Delbridge & Peterson	7,510
Ledingham & Cooper	7,994
T. R. Nickson & Co.	8,150

Wood block pavement on Homer Street, Pender to Smythe:—

McAdam Construction Company	$43,000
Delbridge & Peterson	43,545
Ledingham & Cooper	46,279
T. R. Nickson & Co.	44,125
LaPlaca Brothers	46,673
Romano, Pinto & Co.	45,650
British Columbia Granitoid Company	46,447

Stone block pavement, lane east of Granville Street from Davie to Pacific:—

T. R. Nickson & Co.	$10,991
Ledingham & Cooper	10,200
B. C. Granitoid Company	10,910
LaPlaca Brothers	10,208
Romano Pinto & Co	10,440

The City Engineer will report on these.

Windsor, Ont.—The ratepayers endorsed the by-laws calling for the expenditure of $30,000 for new sidewalks and $1,700 for the erection of a new public lavatory.

FIRES.

Moose Jaw, Sask.—The municipal power house was destroyed by fire. The property is valued at $242,587.

Saskatoon, Sask.—A fire which broke out in the offices of the telephone exchange caused considerable financial loss to the telephone company.

Wainwright, Alta.—$75,000 damage was caused to the business section of this town by fire.

CURRENT NEWS.

Bassano, Alta.—An order has been placed from Calgary for 60 miles of pipe to be used in conveying natural gas from the wells at Bow Island to the city. It is expected that the gas will be available in the city about July 1st.

Eastern Canada.—The Commissioners of the St. John and Quebec Railway have purchased a motor boat and an automobile for the use of the surveying parties working on the lines of this railway.

Medicine Hat, Alta.—The municipal Engineering department have completed plans for a subway to be constructed under Toronto Street, and the council are giving the matter serious consideration. The Board of Works will consult with the officials of the Canadian Pacific Railway in the matter.

Red Deer, Alta.—The ratepayers will vote on a by-law calling for the expenditure of certain sums to provide a motor combination wagon fire hose and other fire fighting equipment.

Toronto, Ont.—The municipal Hydro-Electric Department have opened a store in the business section of the city for the purpose of demonstrating electrical appliances for use on the current supplied by the city.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending May 18th, 1912:—

A London firm who specialize in certain paint oils desire to appoint Canadian agents. A member of the firm will be in Montreal and Toronto in June, and could interview interested parties.

A Liverpool firm desire to be placed in communication with Canadian manufacturers of lump charcoal.

A Glasgow firm would like to hear from Canadian buyers of pumice stone and pumice powder.

A Scottish correspondent is in the market for supplies of clean tin cuttings such as are produced in die stamping from sheet tin.

A London firm make inquiry for the name of the Canadian manufacturer of "Ontario" cotton duck.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending May 24th, 1912:—

A Birmingham firm of consulting and inspecting engineers are open to act for Canadian firms who may be placing orders in Great Britain for machinery and engineering appliances generally.

The Hamburg branch of a London merchant firm desire to get into touch with Canadian bran shippers, especially those represented in Europe.

A Hamburg firm desires to import linseed from Canada, and would like to hear from shippers in the Dominion.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:—

A North of England company manufacturing ready-made bungalows and other buildings wish to extend their trade to Canada.

A London firm of chemical merchants ask to be placed in touch with Canadian manufacturers of acetic acid, of which they seek supplies. They are also interested in acetone, and any other chemical products suitable for the English market.

A London company who are in the market for supplies of white enamelled cornice poles, and also of rings, and ball and spear ends to suit, invite samples and quotations from Canadian manufacturers.

THE TRIPLEX BLOCK

A Triplex Block hung from a temporary rigging and used for laying pipe.

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CALGARY SASKATOON VANCOUVER VICTORIA

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16477—May 9—Directing G.T.R. to within 90 days from date of Order install improved type of electric bell at crossings of Ontario and Erie Sts., Stratford, Ont., 20 per cent. from Railway Grade Crossing Fund.

16478—May 9—Approving location of Algoma Eastern Ry. Station at Espanola, in Twp. of Merritt, Ont. Rescinding Order 16426, April 12, 1912.

16479—May 10—Directing that in Canadian Freight Classification the following articles be transferred from their present positions to the 'Musical Instruments List," and that they be also included in the second-class rating applicable to "Musical instruments, all kinds, not otherwise specified, carloads, minimum 12,000 pounds," namely: gramaphones graphophones, phonographs, records; application, Berliner Gramophone Co., Montreal, Que.

16480—May 7—Approving location of G.T.P. Ry. station to be erected at mileage 119 east of Prince Rupert, B.C.

16481—May 8—16482—May 10—Granting certificates to G.T.P. B.L. Co. correcting errors in right-of-way plans Biggar-Calgary Branch, etc.

16483—May 8—Approving location of Algoma Central and H.B. Rys. terminal station at Sault Ste. Marie, Ontario.

16484—May 9—Authorizing C.N.O. Ry. to cross two highways in Twps. of Clarendon and Litchfield, County Pontiac, Que.

16485—May 9—Authorizing C.N.R. to cross and divert highways in city of Moose Jaw, Sask.

16486—May 8—Approving location of James Bay & Eastern Ry. (C.N.R.) station grounds at St. Prime, Que.

16487—May 10—Approving location of Kettle Valley Ry. Co. from mileage 65 to 76, northwest of Midway, B.C.

16488—May 6—Authorizing C.P.R. to take lands for purpose of diverting Scarlett Rd. and St. Claire Ave., Toronto, Ont.

16489—May 8—Extending until Oct. 16, 1912, time for completion by C.P.R. of siding for city of Moose Jaw, Sask., authorized by Order 15115, Oct. 16th, 1911.

16490—May 9—16491—May 7—Authorizing Campbellford, Lake Ont. & Western Ry. (C.P.R.) to construct its Glen Tay to Cobourg Line at mileage 24.8 from Glen Tay, across tracks of Kingston and Pembroke Ry., interlocking plant to be installed; and at mileage 88.09 over tracks of Central Ontario Ry. in town of Trenton, Ont., by overhead structure.

16492—May 6—Approving location of G.T.P. B.L. Co. station at mileage 25, Cutknife Branch, Saskatchewan.

16493—May 7—Relieving C.P.R. from further protecting crossing third west of Kemptville Jct., Ontario.

16494—May 2—Appointing William Barrett, Judge of the County Court of County of Bruce, Referee, to fix amount of damages sustained by claimants re overflow of Saugeen River caused by bridge of Walkerton & Lucknow Ry. Co. (C.P.R.) at Walkerton, Ont.

16495—May 10—Relieving Vancouver, Victoria & Eastern Ry. from erecting and maintaining fences from Laurier to Danville, B.C.

16496—May 11—Authorizing C.P.R. to construct spur for Cockshutt Plow Co., Ltd., at Regina, Sask.

16497—May 10—Directing that no cars be allowed to stand on any siding within at least 50 ft. of crossing of C.P.R. at Neepawa, Manitoba.

16498—May 10—Approving revised location of G.T.P. B.L. Co. station grounds at Bashaw, Alberta.

16499—April 13—Authorizing G.T.P. Ry. to construct "wye" in Sec. 5, Twp. 42, Range 24, west 3rd M., at mileage 600, Sask.

16500—May 11—Authorizing Midland Ry. of Canada (G.N.R.) to join its industrial spur tracks with industrial spur of C.P.R. leading to works of Canada Malting Co., Ltd., Winnipeg.

16501—May 10—Directing Brandon, Sask., and H. B. Ry. (G.N.R.) to construct transfer tracked to connect with C.N.R. at Minto, Manitoba.

16502—May 11—Authorizing C.P.R. to construct 5 branch lines or spurs for the Dryden Timber & Power Co., Ltd., Dryden, Ont.

16503—May 13—Directing that G.T.P. Ry. be subject to a penalty of $100 per day from date of this Order that work required by Order No 15735 of January 2nd, 1912, remains uncompleted.

16504—May 13—Extending time for commencement of construction of subway until June 15th, 1912, by city of Montreal, over C.P.R. at Park Ave. Order 16359, April 23, 1912.

16505—May 13—Approving revised location of G.T.P. B.L. Co. Regina-Moose Jaw Branch, mileage 0 to 2.1, Saskatchewan.

16506—May 13—Extending for 30 days from date of this Order time for completion of siding authorized by Order 15317, Nov. 10th, 1911, G.T.R.

16507—May 13—Approving Victoria & Sidney (G.N.R.) Ry.'s Std. Freight Tariff of Maximum Tolls in British Columbia.

16508—May 13—Authorizing C.N.R. to construct bridge across Bow River on its Calgary-Vegreville Extension.

16509-10—May 13—Approving revised location of C.N.O. Ry. (Ottawa-Capreel Line) through Twp. of Field, Dist. of Nipissing, mileage 254.53 to 256.2 from Ottawa; and C.N.O. Ry. (Sudbury-Port Arthur Line) through unsurveyed territory in the Dist. of Thunder Bay, mileage 399.21 to 404.46, from Sudbury Junction.

16511—May 11—Authorizing C.N.O. Ry. to cross 6 public roads in Twp. of Foley and McDougall, Ontario.

16512—May 13—Authorizing C.P.R. to construct spur for W. T. Rawleigh Medican Co., Winnipeg, Manitoba.

16513—May 10—Enjoining C.N.R. from interfering with road allowance authorized by Order 14440, July 28, 1911, and to drain borrow pits within 30 days, under penalty of $10 per day, on farm of David Hay, Kinnoull, Alberta.

16514—May 14—Naming delivery of city of Kelowna, B.C. (Express).

16515—May 11—Authorizing G.T.P. B.L. Co. to construct its Tofield-Calgary Branch across highway at mileage 30.

16516—April 10—Approving location of Campbellford, Lake Ontario & Western Ry. (C.P.R.), Glen Tay to Cobourg line, from mileage 58.5 to 68.

16517—May 11—Authorizing C.P.R. to construct spur for Eddy Bros. & Co., Ltd., at Blind River, Ontario.

16518—May 13—Directing that no car or locomotive be allowed to stand on siding, crossing King St., or at Nipissing St., within 50 ft. each way, at Sturgeon Falls, Ont., C.P.R.

16519—May 13—Directing C.P.R. to within 90 days from date of this order install electric bell at Wilson Street, about 1 mile north of Perth Station, Ontario; 20 per cent. from Railway Grade Crossing Fund.

16520—May 15—Restraining C.N.R. and Midland Rly. Co., (G.N.R.), under penalty of $100 after May 20, 1912, from carrying out any provisions of agreement prior to its sanction by the Governor-in-Council upon recommendation of the Board. Re operating of trains of the Midland and G.N.R. Co.'s from International Boundary to Winnipeg, Man., over C.N.R.

16521—May 13—Authorizing municipality of Cap de la Magdeleine to construct highway over C.P.R. at Boulevard Forget.

16522—May 14—Authorizing C.N.O. Ry. to cross by overhead structure public road between Lots 10 and 11, Con. 2, Ottawa, Front, Twp. Nepean, Ont.

16523—May 13—Approving location of C.P.R. station at Springside, Sask.

16524—May 13—Relieving C.P.R. from further protection of crossing at North Glencoe, Windsor Subdivision, Ont.

16525—May 14—Refusing application of K. and P. Ry. for approval of plans, etc., of Godfrey Station, Ontario.

16526—May 14—Directing that C.P.R. construct farm crossing pending completion of public crossing for John Brill, of Boulder and Harry Sawyer, of Revelstoke, B.C.

16527—May 15—Approving Standard plan for 20-foot arch of St. John & Quebec Rly. Co.

16528—May 15—Approving G.T.P. Standard Freight Mileage Tariff, C.R.C., No. 9, to apply from Prince Rupert east, 170 miles, to Carnaby, B.C.

16529—May 15—Extending until 1st September, 1912, time for installation of interlocking plant near Chaudiere Jct., by C.N.R., near Ottawa, Ont.

16530—May 15—16531—May 14—Authorizing C.N.O. Ry. to construct bridge over Duchesney Creek, in Twp. of Commanda, Dist. of Nipissing, and across Little Sturgeon River, Twp. of Beaucage, District of Nipissing, mileage 243.5 from Ottawa.

16532—May 13—Approving location of Campbellford, Lake Ontario and Western Ry. (C.P.R.) at mileage 79.5 from Glen Tay to westerly boundary of town of Trenton, Ont.

16533—May 14—Approving location of C.P.R. station at Jaffray, B.C.

16534—May 15—16535—May 14—Authorizing C.P.R. to reconstruct Red River Bridge, Winnipeg Terminals, and bridge 57.1 on its Cascade Subdivision, B.C.

16536—May 14—Directing C.P.R. to within 90 days to install electric bell at crossing 1¼ miles west of Claremont, Ont. 20 per cent. from Railway Grade Crossing Fund.

16537—May 17—Approving changes and alterations in vicinity of Dufferin Bridge in the city of Ottawa, by C.P.R.

16538—May 17—Authorizing G.T.R. to construct spur for British Canadian Canners, Ltd., Bowmanville, Ontario.

16539—May 15—Authorizing C.P.R. to construct two spurs for Western Canada Flour Mills Co., town of Goderich, Ont.

16540—May 17—Authorizing Guelph Radial Ry. to cross C.P.R. on York Road, Guelph, Ont.

16541—May 17—Directing G.T.R. to within 90 days install electric bell in village of Lynden, Ont. 20 per cent. from Railway Crossing Fund.

16542-43—May 18—Authorizing C.P.R. to reconstruct bridge No. 5.7 on Kippawa Subdivision, Lake Superior Division, and to use and operate bridges 10.4 and 36.5, Farnham, S.D.

16544—May 15—Approving location of Windsor, Essex & Lake Shore Railways new siding, freight shed and station at Essex, Ont.

16545-46—May 18—Authorizing G.T.R. to construct siding for Bechtels, Ltd., near Waterloo, Ont., and for St. Lawrence Starch Co., Ltd., at Port Credit, Ont.

16547—May 20—Authorizing C.P.R. to construct spur for Ontario Rock Co., Ltd., Twp. of Belmont, Ct. Peterboro, Ont.

16548—May 20—Authorizing C.P.R. to reconstruct bridge 94.8, Moose Jaw, S.D. Rescinding Order 15687, December 27, 1911.

16549-50—May 20—Recommending to the Governor-in-Council agreements between C.N.R. and Midland Rly. Co., of Manitoba, (G.N.R.), for operation as joint section from International Boundary to Woodward Avenue, Winnipeg, Man., and permitting above-named companies to operate joint section for thirty days from date when if not approved by Governor-in-Council permission shall cease.

16551—May 20—Approving location of Central Railway Co. of Canada from C.P.R. line near McAlpine station at mileage 7.2 to G.T.R. line near South Indian Station at mileage 38.165, County of Russell, Ontario.

16552—May 21—Authorizing Joseph Battle, Thorold, Ont., to construct chute underneath G.T.R., Stuart St. Station Yd., Hamilton.

16553—May 20—Directing G.T.R. to install electric bell at crossing of 3rd Con. in Twp. of Stamford, Ont. 20 per cent. from Railway Grade Crossing Fund, to be installed by Aug. 1st, 1912.

16554—May 20—Approving location of Kettle Valley Ry. Co., from mileage 4.80 to 19.56, and 19.56 to 38.99, west of Penticton, B.C.

16555—May 20—Authorizing Vancouver & Lulu Island Ry. (C.P.R.), to construct second track across 11 roads and streets in municipality of Point Grey, Province of British Columbia.

16556—May 17—Refusing application of Canadian Press, Ltd., requiring G.N.W. and Western Union Tel. Co., to provide special tolls for press service similar to C.P.R., and directing C.P.R., G.N.W., and Western Union to restore the rate of 25c. per 100 words for "Press Specials" in the Maritime Provinces, effective by 17th June, 1912.

16557—May 21—Authorizing G.T.R., G.B. & S. Ry. (C.P.R.), and C.N.O.R. to operate trains over interlocking plant at Atherley Jct. without stopping account interlocker completed.

16558—May 20—Approving express collection and delivery limits for town of Grand Falls, N.B.

16559—May 20—Directing G.T.P. B.L. Co. to place crossing on Mr. E. D. Sworder's property at Balcarres, Sask., in proper condition for tram traffic; penalty, $25 after June 30th, 1912.

16560—May 21—Authorizing C.P.R. to divert Government Road on its Waldo Branch at mileage 9.92, British Columbia.

16561—May 20—Authorizing C.P.R. to reconstruct bridges 66.77, 19.7 and No 6 on Cartier, S.D., Havelock, S.D., and on Orford Mountain Branch, Eastern Division.

16562—May 21—Authorizing James Bay & Eastern Ry. (C.N.R.) to construct bridge across River a l'Ours, in Township of Ashuapmouchouan, County of Lake St. John, Que.

16563—May 20—Approving location of C.N.Q. Ry. station and baggage room at 16 Island Lake, Ct. Argenteuil, Que.

Volume 22 Toronto, June 13, 1912

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The Canadian Engineer

An Engineering Weekly

THE REVERSIBLE FALLS, ST. JOHN RIVER, ST. JOHN, N.B.

By ARTHUR V. WHITE, M.E. (Commission of Conservation, Ottawa.)

In the report *WATER POWERS OF CANADA*, recently published by the Commission of Conservation, there are mentioned a number of matters related to the conservation of our inland waters. Some of these matters are of special interest and would bear more extended discussion and investigation.

In the portion of this report which deals with the water powers of New Brunswick, Mr. Arthur V. White has drawn attention to the Reversible Falls at St. John, N.B. Having learned that additional data respecting these falls, or rapids, were available, we requested a memorandum of the physical facts so that they may be on record. The memorandum is as follows.—*EDITOR.*

The St. John River at its mouth in the city of St. John has a restricted area and an unusual rock formation in its bed. These features, coupled with the high tides, result in unique phenomena possessing latent water power possibilities.

(Photo by Arthur V. White).

Fig. 1.—The Reversing Falls, St. John, N.B.,

Showing condition of the water surface when tide is running out or in.

The bed of the river, at a place above the C.P.R. and Suspension bridges, known as the Pitch, has a ledge of rock from shore to shore. At the lower stages of the tide in the harbor, the river rushes over this ledge and creates turbulent and unnavigable rapids. During the higher stages of the tide the water level in the basin is so raised as, in part, to overcome the discharge of the St. John River. The incoming tidal waters are then in turn churned, opposed as they are by the ledge of rock just referred to. This cycle of changes takes place twice in the twenty-four hours. The condition of the river during the approaching high and low tide is represented in Figure 1. The river is navigable for large ships at the period of slack water. Figure 2 shows the calm condition of the water surface at slack water.

Thousands of horse power might be obtained if these rushing waters could only be harnessed. Such a project, however, appears impracticable. Schemes have been suggested for utilizing power from these Reversible Falls, and hopes expressed that some plan may yet be devised to take advantage of the power.

There are here presented three diagrams giving some physical data incident to the problem. Fig. 5 is a cross sectional view of the river at the bridges, and Fig. 4 a similar view at the ledges. The soundings in each figure are in feet below low water.

Figure 3 shows the typical regimen of the neap and spring tides at St. John harbor. With regard to elevations —taking the elevation of the bench mark at the customs house as 100.00—low water in St. John harbor is 44.40 and high water 71.40. Low water at Indiantown is 59.53, and high water 60.83.

No attempt should be made to alter the natural conditions which exist in such objects of nature as the Reversible Falls without the most mature consideration. Behind such phenomena there are often wise natural provisions which cannot safely be tampered with. Indeed, in the present instance of the Reversible Falls, it has been concluded by some persons,

(Photo by Arthur V. White).

Fig. 2.—Slack water at the Reversing Falls, St. John, N.B.

The river is only navigable for a short period at the time of slack water.

that the stirring of the waters by the ledge, contributes to the establishment of a temperature mean in the Bay of Fundy waters, which, in turn, assist to keep the harbor of

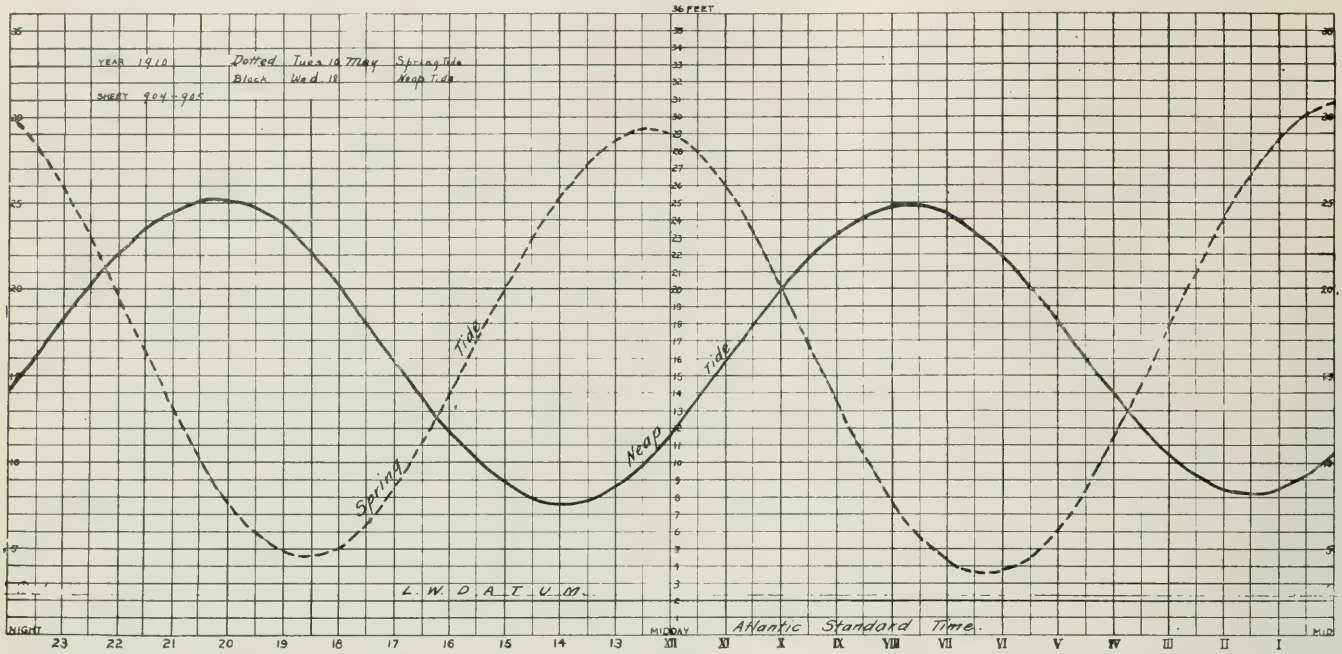

Fig. 3.—Curves showing typical rise and fall of spring and neap tides in the harbor at St. John, N.B.
(Courtesy of Tidal and Current Survey, Ottawa).

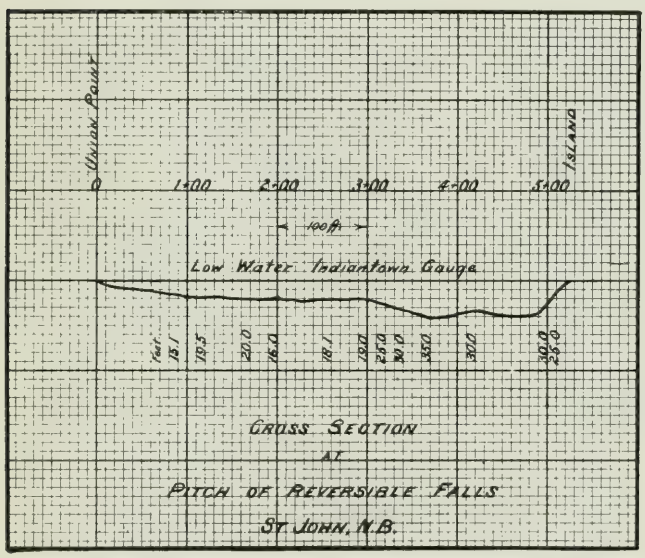

Fig. 4.—Cross section at pitch of Reversible Falls, St. John, N.B.

St. John free from ice, and in consequence assists to make it so valuable a winter port.

ALUMINIUM.

Aluminum, comparatively few years ago a rare metal, too expensive to have any particular economic value, has today come into wide use in a great number of industries. The consumption in the United States in 1911, according to the United States Geological Survey, was 46,125,000 lbs., the price in New York ranging from 18½ to 22 cents per lb.

The use of metal aluminium and its alloys in automobiles, dirigible balloons and aeroplanes is constantly increasing. In the form of magnalium it is used in the beams of analytical balances, and other new alloys are being constantly brought to public attention. The metal is also employed in paper decorations and for wrapping. It is reported to have been used in the textile industries, where it has been combined with silk, to which it imparts a peculiar brilliancy, particularly adapted to theatrical and ceremonial costumes. It has found and is constantly finding a host of applications in smaller articles of everyday use and ornamentation. The Ordnance Department of the United States Army recently awarded a contract for sixty thousand or more aluminium

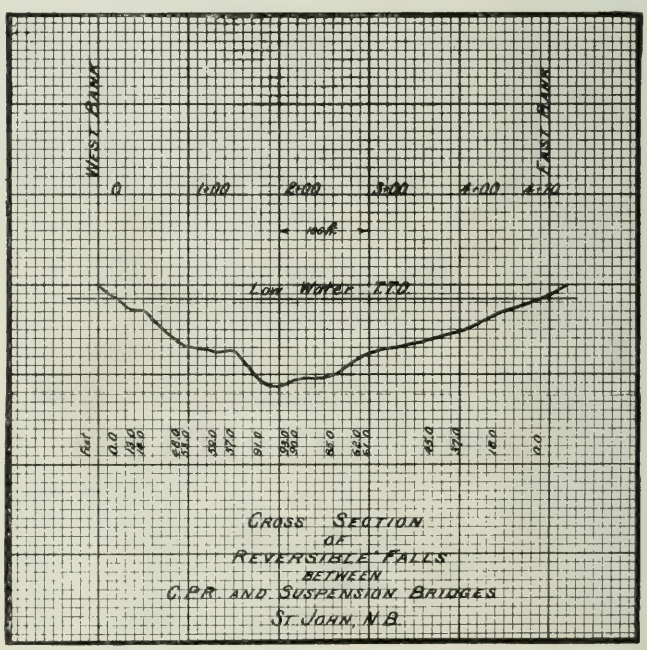

Fig. 5.—Cross section of Reversible Falls between C.P.R. and Suspension bridges, St. John, N.B.

canteens and cups. The metal is now being used in various other ways in the light field equipment of the army.

PUMPING BY COMPRESSED AIR.

In *The Canadian Engineer* of April 4th, 1912, we gave an abstract of a University of Wisconsin bulletin on the air lift pump. The use of compressed air for pumping purposes is becoming of such importance that a recent lecture by Mr. Herbert A. Abrams on this subject should prove interesting.

Mr. Abrams is connected as engineer with the Ingersoll-Rand Company and his lecture was delivered last year before the Department of Mechanical Engineering of Columbia University. It is published in the April, 1912, issue of the School of Mines Quarterly; we reproduce the lecture here almost in full.

The field in which compressed air can be used for lifting and forcing water is divided by Mr. Abrams into four distinct methods:

1. Pumps of the ordinary direct-acting type driven by compressed air;
2. Pneumatic displacement pumps;
3. The "return-air" system;
4. The "air-lift" system.

Direct Acting Pumps.—Mr. Abrams passes briefly over the use of air in place of steam for operating ordinary mechanical pumps. High economy must not be expected in a combination of this kind for the reason that pumps of this type, of themselves, are wasteful of power, and, generally speaking, no consideration is given as to whether they are to be run by steam or by air, no attention is paid to proper ratio of cylinders, and seldom is there any attempt to re-heat the air either before using it in a simplex or duplex pump, or between stages in a compound pump.

"Compressed air should be used in a great many instances where steam is now being wasted, but we are so inclined to listen to talk about 'compressed air efficiencies,' meaning always 'compressed air losses,' that we frequently lose sight of the more important final analysis, which is to define whether a saving in fuel is an actual credit or whether such apparent balance is not over-balanced in the item of extra labor or up-keep or general utility."

As compressed air is found driving steam pumps in mines, quarries, and wherever there is an available supply of air, Mr. Abrams briefly gives the simple rules used for proportioning pumps and the volume and pressure of air needed to run them.

The simplest way to find the quantity of free air and the pressure required is first to determine at what speed and under what air pressure the pump is to be run, and calculate the cubic feet displaced per minute at the pressure necessary to do the work. This may readily be converted into terms of free air at sea level or the greater quantity at any altitude. To this must be added a percentage, say 10 per cent., for the loss due to leakage.

With a given air pressure and head of water, the diameter of the air cylinder may be found by the rule: Determine the pounds pressure of resistance by taking one-half the elevation in feet, as representing the equivalent pressure in pounds, add one-third excess for pumps over 7-in. stroke. Divide this result by the pounds pressure of air at the pump, and the result will be the proper ratio.

Knowing the dimensions of the air cylinder and pressure, the free air requirements can be calculated by means of the simple formula,

$$V = 1.1 \frac{ASP}{144P_a}$$

where

V = volume of free air per cubic feet per minute,
S = piston speed of pump in feet per minute,
P = absolute air pressure at pump,
A = area of air cylinder,
P_a = atmospheric pressure at any elevation.

Problem.—Pump assumed over 7-in. stroke; head, 360 ft.; air pressure, 60 lb.

To find area of air cylinder, add one-third to the head (360 plus ⅓ = 480 ft.). Take one-half of this head as the equivalent pressure (240 lb.). Dividing 240 lb. by 60 lb. pressure gives a ratio of 4, or, in other words, the air cylinder should have four times the area of the water cylinder.

Having decided on a pump to handle 50 gal. of water per minute at a piston speed of 100 ft. as the proper size,

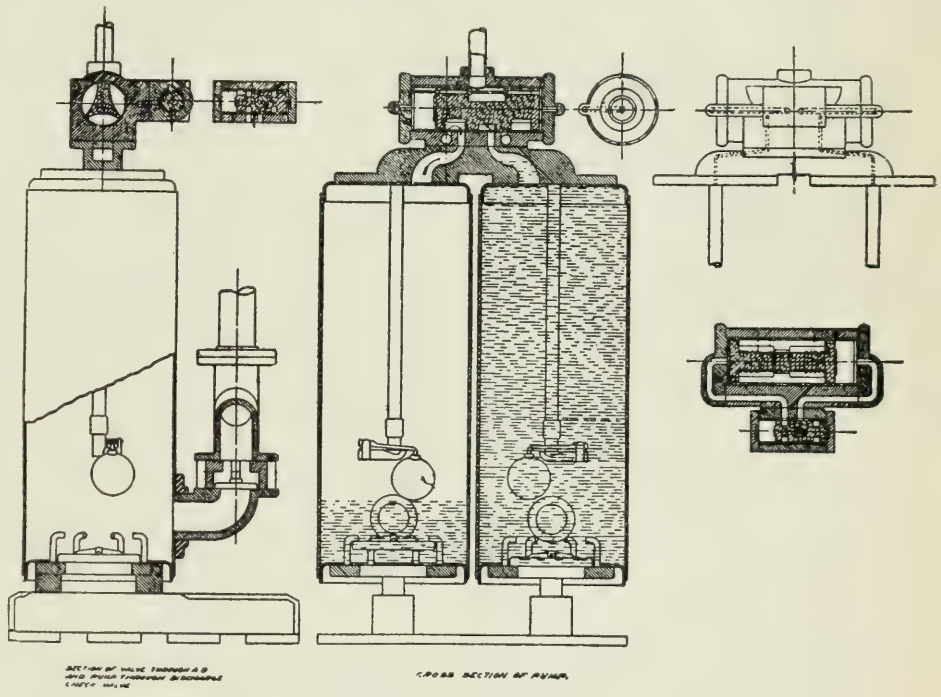

Fig. 1.—Compressed Air Displacement Pump.

we find, either by calculation or by manufacturers' tables, that the water end is represented by 3½ × 7-in. cylinder. Our ratio having been established at 4 to 1, the diameter of the air cylinder will be 7 in. and its area 38.5 sq. in.

Now, substituting in our formula the values so far obtained, we have,

$$V = 1.1 \frac{38.5 \times 100 \times 75}{144 \times 15} = 148 \text{ cu. ft. free air per minute,}$$

showing a total efficiency referred to I.H.P. in steam cylinder of compressor of approximately 19 per cent. If the air is re-heated to 300 deg., the requirement will be reduced about one-third.

Pneumatic Displacement Pumps.—Fig. 1 is a sectional view of a compressed air displacement pump. This pump uses air non-expansively, but owing to the fact that air comes in direct contact with the water pumped, without the intervention of moving parts, such as pistons or plungers,

the work under moderate heads, up to 100 ft., is done in a satisfactory and efficient way.

The pump consists of one or two cylinders with inlet and discharge valves for water, and a valve mechanism controlled by floats or other means for admitting compressed air directly to the surface of the water within the tanks, and for exhausting the air after the water has been expelled. The tanks must be submerged in a suitable sump or cistern properly protected, of sufficient depth to insure that the pump tanks will fill properly by gravity. It will be seen that the pump is really a simple apparatus. Water enters through the large inlet valves at the bottom. Air pressure entering at the top is alternately delivered to the chambers, expelling the water in them through the discharge valves and pipe. When a tank is nearly empty the contained air is exhausted through a port in the valve mechanism, while water replaces it through the foot valve as soon as the air pressure is relieved, the alternate discharge being entirely automatic.

The proper field of this device is that calling for the pumping of water at some distance from the source of power, where there is an unobstructed supply and a limited lift. Valves in the power house on the air line to the pump, or to as many of them as may be needed to pump from a number of sources, control the operation, and pumping must continue as long as air is supplied.

The advantages are that these pumps can be easily installed, and where an existing supply of compressed air is available the cost of equipment is low. There is no pump house to build and maintain at the water supply; the operation is controlled in the engine room; there are no piston or plungers to repair and renew, and the wear on valves is less than in any ordinary direct-acting mechanical pump. Neither lubrication nor packing is required and the attention charges are reduced to a minimum. Its working is not affected by muddy or gritty water.

These facts adapt the pump for dye works, bleacheries, pulp mills, and for handling solutions. It may be used to take water from a cistern or reservoir filled by the air-lift from wells, or placed in a remote sump in a mine or quarry, it can be employed to deliver water to the main pumps.

Since the pump operates by the direct displacement of a volume of liquid by a volume of air under suitable pressure, it follows that simple rules can be given for arriving at the volume of air and pressure needed to do the work.

Reduce the quantity of water in gallons per minute to cubic feet. Multiply the total head (static head plus water-pipe friction) by 0.434; this gives the working air pressure at the pump. Next find the ratio of air pressure to atmosphere, which multiplied by the cubic feet of water per minute gives the cubic feet of free air per minute needed at the pump to displace this volume of water.

Knowing the volume of free air required, 5 to 10 per cent. should be added for leakage and clearance according to the special conditions.

This is net, actual free air and not piston displacement of compressor; therefore, in figuring on a compressor to do the work, volumetric efficiency must be taken into consideration, following the general practice in such cases, according to the pressure, size and type.

Problem.—Source of supply, a river; distance from power house, 1,000 ft.; lift, 60 ft.; diameter discharge main, 4 in.; quantity of water required per minute, 150 gal.

150 gal. = 150 ÷ 7.5 = 20 cu. ft.

Static head ..... 60 ft.
Friction head 150 gal. per minute in 4-in. pipe 1,000 ft. long ..... 16 ft.

Total head ..... 76 ft.

$$76 \times 0.434 = 33 \text{ lb.}$$

$$\text{Ratio } r = \frac{33 + 15}{15} = 3.2$$

Free air = 20 × 3.2 = 64 cu. ft. per minute.

Allow 10 per cent. for leakage and clearance = 70 cu. ft. net.

If the compressor selected will show a volumetric efficiency of 80 per cent., the piston displacement required will be 70 ÷ .080 = 88 cu. ft. per minute.

$$\text{Theoretical horsepower} = \frac{150 \times 8.33 \times 76}{33{,}000} = 2.88.$$

I.H.P. in steam cylinder of compressor = 8.5.

Total efficiency = 2.88 ÷ 8.5 = 33 per cent.

Return Air System.—The elevation or transfer of water and other fluids or semi-fluids by direct displacement with compressed air is so natural and self-evident a proposition as to need almost no suggesting. It appeals at once merely on the ground of convenience and simplicity. But the principle as ordinarily applied has been open to the objection that it was not economical.

One characteristic of the ordinary, plain, displacement pump is waste of power entailed by direct release of the displacing air after the fluid is ejected from the pump tank. This air, after doing its work, is still at practically full pressure, therefore having all its potential energy of expansion. Its direct exhaust into atmosphere after displacement is the throwing away of this expansive power without any useful effect.

If air pipes are carried back from the pump to the compressor so as to add the residual pressure after displacement to the reverse side of the compressor piston, where it will help in compressing air into the pump tank, we have a return-air, expansive displacement pump, operating at good economy.

Mr. Abrams emphasizes, at this point, the fact that both the plain displacement pump and the "return air" system have the following advantages which are unique in that, while other pumping systems have some of them, no other systems combine them all to such remarkable degree:

1. Simple in construction, installation and management.
2. Wholly automatic in operation.
3. Under instant and complete control from the compressor room, however distant.
4. No delicate mechanism exposed to corrosive or abrasive action.
5. No oil or other lubricant required by the pump.
6. Not affected by any excess submergence except that operation is improved under a hydraulic head.
7. Applicable to the pumping of all fluids or semi-fluids, as well as mud, sand, or any debris which will pass the valves.

Where water is to be pumped, the field of the pneumatic displacement pump and the return-air system is that in which large volumes are to be handled from a generous source of supply, where complete submergence can be secured, such as in a river, lake, mine or quarry sump, large spring or an excavated well. This, at once, opens to them the supplying of water for small municipalities, shops, mills, factories, etc.

The fact that these systems will handle anything sufficiently fluid to pass their valves adapts them also to the handling of solutions in salt works and bleacheries; the moving of semi-fluids, as in pulp mills; the handling of cement, slurry and marl; the pumping of glass sand for glass factories; elevating salt solutions in salt works, and the pumping of sewage.

Under normal conditions it is safe to say that the return-air system will show an average efficiency of 50 to 55 per cent., this efficiency being the ratio of horse-power of water lifted to the indicated horse-power in the steam cylinder of the air compressor, including all losses. It is easy to estimate from these figures just what they mean in terms of fuel saving.

Yet the question of fuel economy is but one argument in favor of the return-air system. Another argument is that the compressed air system may be operated with a far less boiler horse-power, with a corresponding reduction in first cost of boiler plant, interest, maintenance, repairs and firing cost. Where a plant is crippled by a shortage of boilers, the substitution of the return-air system for a less economical pumping system will relieve the embarrassment.

Continuing still further the argument for this system, Mr. Abrams notes that the tank equipment needs absolutely no care. The operation being entirely under control from the engine room, the engineer can at any time start, stop or vary the pumping. There is no possibility of drowning out the system. In fact, it operates with proportionately less power as the height or head of water above the tanks increases. It cannot become choked by such silt or dirt as may enter a mine sump.

The return-air system cannot be classed as a pump, or as machinery of the kind regularly catalogued and listed. It is a complete system in itself, consisting of an air compressor, a receiver, a reversing switch, two air lines, each leading from the compressor through the switch to one pump tank, and two pump tanks, all in a closed circuit, in which, by a regular cycle of operations, one air volume is compressed, expanded, recompressed and re-expanded, corresponding with a discharge of one of the pump tanks.

The principle of operation is simple. Compressed air is admitted to a tank filled with water, or any fluid, forcing the fluid out through a check valve and pipe line, and at the same time the compressor is drawing air from the other tank, the charge of air being regulated so that when a tank is empty, the other is full, at which time the switch reverses, thereby reversing the action of the tanks.

The cycle of operation will be better understood by referring to Fig. 2; A and B are twin displacement tanks, preferably completely submerged, though they operate if so placed as to be filled by siphon action. A^1 and B^1 are the two air pipe lines. C^1 and C^2 are discharge check valves preventing the return of the fluid ejected.

D^1 and D^2 are check valves preventing the discharge of the fluid through the inlet. E is the discharge pipe from both tanks.

F is the automatic switch controlling the pumping cycle. G^1 and G_2 are the tank risers.

H is the compressing cylinder of an air compressor. J is the automatic compensating valve which keeps the system supplied with air.

In the diagram as shown, air is being withdrawn by the compressor H from the tank B and is being compressed in tank A. At the same time the fluid is entering the tank B through check valve D^2, while it is being forced from the tank A through the riser G^1, the check valve C^1 and the discharge pipe E.

The mathematical analysis of the system is difficult. Any one interested in a full discussion of the problem will find it fully brought uot by Prof. Elmo G. Harris in Vol. 54 of the Transactions of the American Society of Civil Engineers.

In order to proportion a plant correctly, the needed data are as follows:

Qw = the quantity of water to be pumped in cubic feet per second.

h = the total lift, or head, in feet.

l = the total length of air pipes, the distance from compressor to pump tanks.

Having these, we must compute:

Q_a = the volumetric capacity of the compressor, or the piston displacement in cubic feet per second.

V = the volume of each pump tank (cubic feet).

d = the diameter of air pipe (in inches).

D = the diameter of water pipe (in inches).

H.P. = the maximum horse-power required of the steam end of compressor.

From the formula:

$$Q_a = Qw\ [1 + 1.4 \log_e R]$$

the following Table I. has been prepared, showing the size of compressor, pipes, etc., required for various heads, based on 100 gal. of water per minute; for other quantities, the dimensions will be directly proportional. The table assumes the pump tanks to be fully submerged.

Table I.—Dimensions for Return-Air System.

Lift in feet.	Capacity of compressor in cubic feet per minute piston displacement for 100 gals. per minute.	Max. I. H. P. of air cylinder.	Max. I. H. P. of steam cylinder.	Average H. P. of steam cylinder.	Area of air pipe in sq. in. for each 100 gal. capacity of plant.	Area of water pipe in sq. in. for each 100 gal. capacity of plant.
50	39.84	2.74	3.22	2.80	0.96	7.70
60	42.78	3.28	3.85	3.37	1.03	8.25
70	45.30	3.85	4.53	3.93	1.09	8.73
80	47.70	4.45	5.22	4.49	1.14	9.12
90	49.80	5.03	5.91	5.05	1.20	9.60
100	51.84	5.67	6.67	5.61	1.25	10.00
110	53.64	6.31	7.43	6.17	1.29	10.30
120	55.44	6.96	8.18	6.73	1.33	10.60
130	57.00	7.62	8.97	7.29	1.37	10.95
140	58.50	8.30	9.75	7.85	1.41	11.30
150	59.94	9.00	10.60	8.41	1.44	11.50
160	61.38	9.75	11.45	8.98	1.47	11.75
170	62.64	10.42	12.25	9.54	1.50	12.00
180	63.84	11.13	13.08	10.10	1.53	12.25
190	64.98	11.85	13.95	10.66	1.55	12.40
200	66.12	12.76	15.00	11.22	1.58	12.65
210	67.20	13.35	15.70	11.78	1.62	12.95
220	68.28	14.09	16.60	12.34	1.64	13.10
230	69.24	14.92	17.35	12.90	1.67	13.35
240	70.20	15.68	18.45	13.46	1.69	13.50
250	71.10	16.46	19.35	14.02	1.71	13.70
260	72.00	17.24	20.25	14.58	1.73	13.82
270	72.84	18.00	21.20	15.14	1.75	14.60
280	73.56	18.80	22.10	15.71	1.77	14.20
290	74.28	19.60	23.10	16.27	1.79	14.30
300	75.06	20.45	24.00	16.83	1.80	14.40

Air-Lift System.—The air-lift system of pumping, measured on the power basis, is not an efficient method of raising water, but where it is and can be applied, it fills a certain field and in that class of work does service that no other pump can do, and does it in a most satisfactory way. This method of pumping has been most generally applied to raising water from artesian wells. There are not many underground formations in which wells can be located close together without affecting each other when pumping, and for that reason it is best to spread them out on a line of what we call the line of underground flow. Some formations are so tight that wells have but little capacity, and in such formations it is particularly necessary that the wells should be scattered and pumped moderately. For the reason that separate pumping units entail high first cost and labor for

attendance, the air-lift system is recommended. An economical central pumping station will serve any number of wells, compressed air being capable of transmission in proper sized pipes for great distances without serious loss.

The required equipment consists of an air compressor located at some convenient point, preferably in some existing power station where it can take advantage of economical steam conditions, an air receiver, and a pipe line leading from the receiver to the well or wells. The pump proper consists of nothing more than two plain pipes, one for air

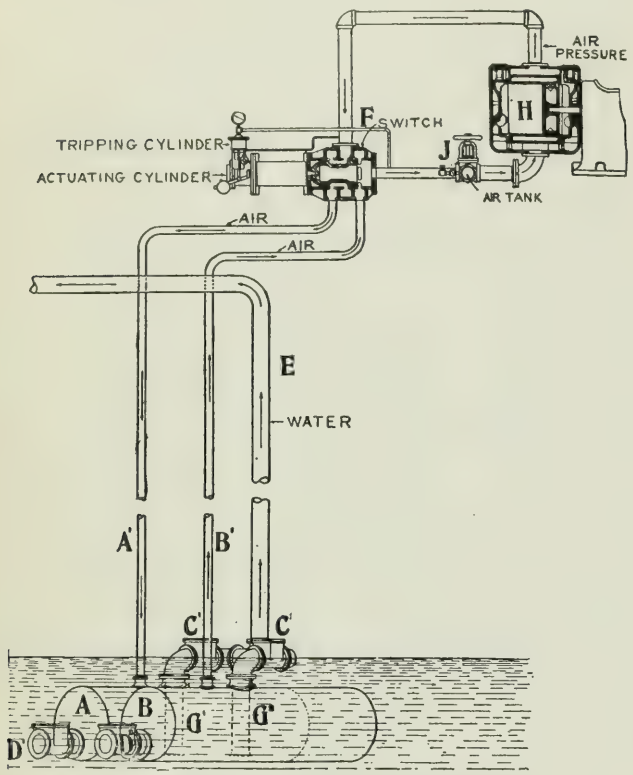

Fig. 2.—Return-Air Displacement System.

and one for water; these pipes run down inside of the well and are submerged for a certain depth proportionate to the lift when the pump is at work. Fig 3 shows the different methods of piping wells. All wells are not alike, therefore it is a special problem in every case to determine the size and arrangement best suited.

Each method here shown has its use, depending upon the diameter and depth of the well, whether the well is cased or not, the lift, volume of water to be pumped, and character of the water-bearing strata. The arrangement most generally used, where conditions permit, is shown in No. 1, Fig. 3. This is the Pohle or "side-inlet" method, in which the discharge and air pipes are placed side by side in the well, joined by a suitable foot-piece.

In No. 2, Fig. 3, compressed air fills the annular space surrounding the up-take pipe and is free to enter the rising column at all points of its periphery, at the same time acting without obstructing or contracting the discharge pipe anywhere

Fig. 4 shows the tubular foot-piece. This device aims to provide a means for actually dividing air into fine streams, which we have found to be the best condition in which air can be introduced into the rising main. Air from the supply pipe fills the hollow base of the foot-piece. The base-plate is studded with ¼-in. wrought-iron pipes about 18 in. long extending upwards to a point where the water passes from the foot-piece into the discharge pipe, at which juncture the bubbles of air are released. Ample space is provided for the inflow of water to the foot-piece through the bottom openings, augmented by the larger side inlets shown. Thus we have in the foot-piece designed for a 5-in. discharge pipe a subdivision of air into thirteen ¼-in. streams, with the added advantage that these separate small pipes will tend to act as governors to control the discharge of the air.

The usual capacities allowed for the side-inlet method are as follows:

Air Pipe Connection.	Water Pipe.	Size Well.	Maximum Economical Capacity on Moderate lift. Gals. per min.
½ in.	1 in.	3 in.	7
¾ "	1½ "	4 "	20
1 "	2 "	4½ "	35
1 "	2½ "	5 "	60
1¼ "	3 "	6 "	100
1½ "	3½ "	7 "	140
1½ "	4 "	8 "	190
1½ "	5 "	9 "	250
2 "	6 "	10 "	350

No. 3, Fig. 3, shows the Sounders system. A central discharge pipe is suspended in the well, the air passing down between it and the well casing. If the well is not cased a second pipe must be used outside of the main discharge pipe, the air, as before, filling the annular space between the two pipes. In estimating pipes under this system it is usual to allow capacities as follows:

Lift, 25 ft., 15 to 20 gal. per minute per square inch area water pipe.

Lift, 50 to 125 ft., 12 to 15 gal. per minute per square inch area water pipe.

No. 4, Fig. 3, is the so-called "central air pipe" system. This method is generally used where the lift is low, and to obtain the greatest possible output from what are termed "strong wells," i.e., wells having a strong static pressure and finding their supply in gravel or open rock formations. The air pipe is suspended in the well without the usual discharge pipe. The proper sized air pipe for different sizes of casing and capacities are about as follows, depending upon the lift and submergence:

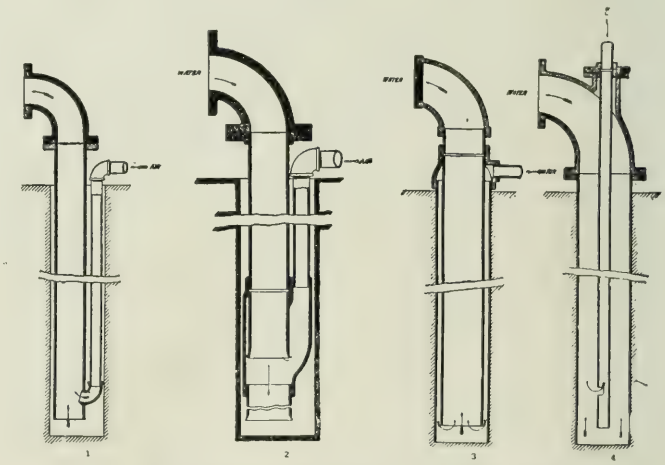

Fig. 3.—Different Methods of Piping Wells.

Size of Casing.	Size of Air Pipe.	Capacity. Gal. per min.
3½ in.	1¼ in.	80 to 100
4 "	1½ "	100 to 150
5 "	2 "	150 to 250
6 "	2 "	275 to 375
8 "	2½ "	500 to 665
10 "	2½ "	775 to 1000

Notwithstanding the fact that the air-life system has been in commercial use for nearly 20 years and thousands of plants are in daily operation all over the world, no mathematically correct formulas have been published covering the design of these pumps, nor is there exact information at hand for calculating the volume of air and pressure required to operate them under all conditions. This is due to a number of variable factors which enter into each proposition, and if we are to undertake to derive a practical working formula we must assume certain efficiencies for the system, and assume also that the wells will be properly piped to meet the proper relation of submergence to lift.

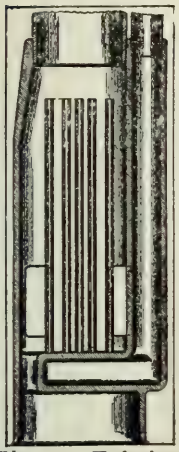

Fig. 4.—Tubular Foot Piece.

Although impossible to construct a formula which can be applied uniformly to all conditions met in this class of work, yet, as Mr. Abrams points out, we can define the trend and introduce certain rules which will permit any engineer to calculate the requirements for any given proposition when **the exact** data covering the case are known. The data required and the factors entering into these calculations may be reduced to the following:

V_a = free air piston displacement required to raise 1 gal. water.

h = total vertical lift in feet.

H = submergence in feet.

C = constant (efficiency of the system).

Before proceeding, the symbols above written must be clearly understood.

V_a is the free air (piston displacement of the compressor) required to raise 1 gal. of water, due allowance having been made for the ordinary volumetric efficiency of the air compressor. If the compressors are in bad shape or poorly designed, of course, more displacement will be required from such a machine than from a well-designed compressor in good working order.

By "lift" is meant the total vertical lift from the pumping level of the water in the well to point of discharge.

"Submergence" is the depth the air pipe is submerged below the pumping level of the water in the well, and is an important factor in any installation; the percentage of submergence, so often heard of, is the percentage of the total length of pipe which is submerged in the solid water when pumping. The necessary percentage of submergence varies in accordance with the lift; low lifts require proportionally more submergence than high lifts; or, in other words, the necessary submergence decreases as the lift increases. The range of these percentages lies within the following limits: For lift of 20 ft., 66 per cent.; for lift of 500 ft., 41 per cent. The average best percentage in the class of work usually encountered will lie between 50 and 65 per cent. Submergence also governs the pressure required, both the starting pressure and the working pressure. The air-lift differs from other pumps in that the pressure necessary to raise the column of water does not depend upon the head, h, but upon the submergence, H, or, in other words, H is the actual head against which the air pressure acts.

The first step in a calculation of this kind is to determine from the lift what the proper submergence should be, and knowing this submergence, the work can be easily calculated on the basis, $P = 0.44\ H$.

We are now ready to calculate the air volume required (free-air piston displacement) to raise 1 gal. of water. The following formula may be used, which closely approximates average practice (in part suggested by Mr. Edward A. Rix):

$$V_a = \frac{h}{C \log \frac{H + 34}{34}}$$

The annexed table also shows the value of C calculated from the efficiency of the system under various heads, with proper submergence.

Table for Value of C.

h = Lift.	C = Constant.
10 ft. to. 60 ft.	245
61 ft. to 200 ft.	233
201 ft. to 500 ft.	216
501 ft. to 650 ft.	185
651 ft. to 750 ft.	156

Problem.—Given a bore-hole, well, or shaft 250 ft. deep, the water in which stands 50 ft. below the ground surface, but which falls 25 ft. when being pumped at the rate of 200 gal. per minute, and it is required to raise the water 25 ft. above the ground:

Standing water level in well, measured from surface.. 50 ft.
Drop when pumped ..... 25 ft.
Elevation above surface to raise water..... 25 ft.

Total lift .....100 ft.

If the best ratio of submergence for a lift of 10 ft. is 58 per cent., then

$$H = \frac{h \times 0.58}{100-58} \text{ or } \frac{100 \times 0.58}{100-58} = 138 \text{ ft.}$$

and applying our formula,

$$V_a = \frac{100}{C \log \frac{138 + 34}{34}}$$

and further introducing the value of C from the table, we have

$$V_a = \frac{100}{233 \times 0.704151.} = 0.60.$$

V_a = 0.60 cu. ft. (piston displacement) per gallon of water; hence for 200 gal. 200 × 0.60 = 120 cu. ft. will be required.

The next calculation is to find the starting and the working pressure. Observe that the normal or standing water level is 25 ft. higher than the working, which indicates a submergence at the beginning of operations equivalent to 138 + 25 = 163 ft. The starting pressure must be just sufficient to overcome that due to the height of the water column above the footpiece.

163 × 0.44 = 72 lb. gauge, the starting pressure.

0.44 H = 138 × 0.44 = 61 lb., the working pressure.

The actual pumping level in a well or group of wells can seldom be known in advance to a test. It is customary to assume certain conditions of lift and submergence, basing such conclusions on experience, and proceed to pipe the wells accordingly. After the piping is installed and the working conditions arrived at, the submergence is altered to suit by raising or lowering the pipe in the well until the best ratio is established.

The quantity of water a well will yield depends upon its diameter and the natural flow. It is also essential that the pipes both for air and water be properly proportioned, for the reason that velocity of flow is an important factor; if too large a pipe is used the air gets through without doing all the work it should, and, on the other hand, if the velocity is too high there is undue friction loss and also inefficient expansion of the air bubbles. The best results are ordin-

arily obtained by providing for a discharge of 12 to 15 gal. per square inch area of discharge pipe.

Tables are available for determining the friction loss of air pipes. It is, of course, essential to keep this loss within reasonable limits. The flow should not exceed 1,500 ft. per minute.

One reason why the air-lift has been so popular, aside from its flexibility and simplicity, is the fact that the yield of a well is frequently increased by its use. Wells can be cleaned of sand, keeping open the water-bearing seams. As there is little apparatus in the well, an unobstructed flow is assured. The air-lift will handle all the water a well yields, but if a given well is equal, at its maximum, to a flow of 50 gal. per minute the air-lift has so miraculous power whereby the yield can be increased.

Water is also purified and improved by the intimate commingling with air on its passage through the discharge pipe. There is a complete aeration as the water flows upward, putting it in condition to throw off sulphur gas, precipitated iron, and in a measure prevent vegetable growth.

Special Uses for the Air-Lift.—The pumping of oil wells offers a superior opportunity for the air-lift, and in this line of work compressed air has been pre-eminently satisfactory. One of the advantages possessed by the air-lift, whether it be in pumping water or oil, is the ability of the system to handle sand and gritty matter.

On account of the facility with which the air-lift, owing to the fact that no working parts come in contact with material being pumped, can handle sand, mud, and other substances destructive to ordinary mechanical pumps, it is an ideal method for pumping in the following cases:

1. Slimes, a mixture of water and the very fine portions of crushed ore coming from a reduction plant.

2. Sand and water for stone saws. All preparation necessary for work of this kind is a "master" well or pit sunk to a proper depth to provide the necessary submergence.

3. The air-lift has done excellent work as a dredge pump and if its usefulness along these lines were better appreciated we should see a great many more installations. The arrangement of air-lift units on a scow, with proper facilities for raising and lowering the pipes, presents unexcelled features of simplicity and capacity.

4. Agitation of slimes in the cyanide process also offers an opportunity for the air-lift, as complete and satisfactory aeration can be brought about by placing an air-lift in a cyanide tank specially designed for the purpose.

The air-lift is past the experimental stage and is taking its place with other applications of compressed air where steady, reliable results are appreciated.

TESTS ON REINFORCED COLUMNS.

The results of an extensive series of tests of the strength and elastic properties of concrete columns reinforced with spirals and longitudinal rods, conducted by Prof. M. O. Withey, assistant professor of mechanics in the university laboratory for testing materials, are contained in Bulletin 466, University of Wisconsin, Engineering Series, Vol. 7, No. 1, just issued. The tests were made from a rather comprehensive point of view, no less than seven elements being thoroughly investigated; to do this, sixty-six columns of commercial size were tested. The findings, which in most cases are noteworthy, briefly comprise the following:

1. With respect to varying the richness of the mixture, the fact was developed that rich mixtures are more economical than lean ones, provided materials can be obtained at average prices. It was found that more economical mixtures are produced when the proportion of cement to aggregate, by weight, lies between 0.2 and 0.7.

2. With reference to the effect of varying the percentage of spiral reinforcement, the tests showed that although the yield point is practically independent of the spiral reinforcement, the ultimate strength and toughness are directly affected by it; one per cent. of closely-spaced spiral of high carbon steel was shown to be sufficient for lateral reinforcement.

3. As to varying the percentage of longitudinal reinforcement, it developed that the addition of longitudinal steel can be made to considerably increase the yield point, ultimate strength and stiffness. As, however, cement is ordinarily a more economical reinforcement than steel, it does not seem advantageous to use in combination with a rich concrete, more than two or three per cent. of longitudinal steel.

4. In regard to the effect of repeated or time loadings, no definite conclusion was reached, although the results plainly indicate that there is practically no increase in set or deformation after a few repetitions of loads equal to 40 to 50 per cent. of the yield point.

5. With respect to columns eccentrically loaded, the close agreement between the values derived from the tests and the theoretical values shows that common formula

$$S = \frac{P}{A} = \frac{Mc}{I}$$

for short homogeneous columns eccentrically loaded, is applicable to reinforced concrete columns.

6. As to the effect of differences in end conditions, that is, the bearing surfaces, the tests disclose that the strength of a column will be about as great when resting on a footing as when bedded on a metal plate, provided the base is properly reinforced.

7. With reference to the relative value of plain and deformed bars for longitudinal reinforcement, the results with the use of corrugated bars of high carbon steel were so uniform and the strengths so high that this type deserves much consideration. The use of deformed bars of high elastic limit was shown to be more economical, with certain ratios of unit prices, than plain round bars of mild steel.

The bulletin contains a very complete bibliography of published matter on the subject of testing reinforced concrete columns.

AN INTERESTING JUDGMENT.

A legal judgment that has a particular interest to contractors and engineers has been handed down in the Court of Review recently in Montreal, Que. The case arose over the collapse of a tank. The lower court had condemned the defendants to pay $9,590.68 damages on the grounds that the collapse of the tank on the building was due to the weakness and insufficiency of the walls, and that it was incumbent upon the defendants, as contractors, to assure themselves of this condition, before attempting to erect the superstructure and tank. The Court of Review whilst maintaining the damage award, holds that the collapse was due to a defect in the construction of the steel work supporting the tank. For this the defendants were also responsible by reason of the fact that they had undertaken to carry out the work on the understanding that they would look after all details connected with such work.

THE DIGESTION OF SEWAGE SLUDGE.

By Charles Saville.*

There are, as is now well appreciated, many advantages in providing for the rapid and complete digestion of sewage sludge. In this connection "digestion" refers to the thorough decomposition, or rotting out, of non-resistant organic matters which are easily putrescible and thereby capable of creating a nuisance.

The quantity of sludge deposited from sewage is large. In a fresh condition, and containing 90 per cent. or more of water, it sometimes amounts to as much as 750 cu. ft. per month per thousand persons connected with the sewers, this being the figure reported from Elberfeldt, Germany, where the sewers are built on the separate system. Furthermore, fresh sludge usually has an objectionable odor which may continue to be noticeable for a long period. Because of these two characteristics, the disposal of fresh sewage sludge, particularly in the vicinity of thickly settled communities, is a difficult problem.

With well-digested sludge, on the other hand, the volume to be handled is comparatively small, being, under certain conditions, less than one-fifth as great as with fresh sludge. This great difference is due to the smaller water content of the digested sludge and to the breaking down, or rotting out of the easily putrescible organic matter, part of which passes off in the form of gases. The extent to which fresh sludge is reduced in volume by digestion depends on numerous factors, including the nature of the organic matter in the sludge, the amount of mineral matter present, the condition under which the digestion takes place, the length of the digestion period, etc., etc.

It is also true that well-digested sludge has no objectionable odor, because the easily putrescible organic matter in it has been thoroughly rotted out. Under certain conditions digested sludge flows easily. Furthermore, on account of the entrained gases of decomposition it dries quickly to a porous, earthy mass which can be readily handled and easily disposed of.

It is thus evident that there is much to be gained from a complete digestion of sewage sludge, and throughout the past 40 years considerable time and thought has been spent in attempts to find the most efficient means of bringing about the desired results.

Perhaps the best known method of effecting the digestion of sewage sludge is the "septic tank," in which the deposited sludge is allowed to digest in contact with the flowing sewage. Under these conditions the rate of digestion is not usually high, and as the digestion of the sludge makes the sewage itself septic and malodorous, and at the same time interferes with the settling action, the ordinary septic tank is gradually going out of favor.

The next step in advance was taken at the State Experiment Station in Lawrence, Mass., by removing the deposited sludge from the settling tank to a separate digestion tank. This method of sludge treatment was first tried some 12 or 13 years ago, and has since been adopted on a practical scale in England as well as at a few places on the Continent; but only to a small extent in this country. In some instances it has proved comparatively successful, and the method has recently been adopted by the city of Baltimore, Md.

At many places, however, the results have not been entirely satisfactory; in Germany, for example, as reported by Prof. Thumm in his recently published book on sewage disposal.* Similar unsatisfactory results have also been reported from the sewage testing stations at Philadelphia and Chicago. It is not strange, therefore, that the past 10 years have witnessed the search for a still better means of bringing about the desired digestion.

This has gradually resulted in developing, first in England and then in Germany, a tank with two chambers; one, through which the sewage flows and in which the suspended matters settle out; the other, for the storage and digestion of the sludge, being so arranged that not only the sludge, but also the products of digestion, cannot have an injurious effect on the sewage in the settling chamber. In this type of tank, in the form in which it has been developed in Germany, there is no flow of sewage into or through the sludge chamber. Consequently the soluble organic matters in the sewage standing in the sludge chamber soon become completely decomposed, after which the digestion of the sludge takes place in a liquid which is practically free from easily putrescible organic matter.

Such tanks are spoken of as the Emscher or Imhoff tank. They have been operating on a practical scale in Germany for six years and have given uniformly good results. In this country there are as yet only a few in operation; but wherever such tanks have been given a thorough test on a small scale with ordinary city sewage, the digestion of the sludge has been excellent, and a large number of municipalities throughout the country are now planning to use them.

The time thus seems appropriate for inquiring into the relative advantages of the separate sludge digestion tanks and the Imhoff tanks.

In discussing this question the writer would suggest the advisability of keeping in mind the following points of view:—

First.—Can separate sludge digestion tanks be made to give as good results as Imhoff tanks; with respect not only to the character and quantity of the digested sludge; but also to the effect on the settled sewage and subsequent process of purification, and to the production of objectionable odors, both during the settling of the sewage and during the digestion and subsequent disposal of the sludge

Second.—Will the digestion of the sludge be as rapid in separate sludge digestion tanks as in Imhoff tanks, and will the cost of construction and operation be as low?

Sludge which has been thoroughly digested in separate tanks probably does not differ materially as to character or quantity from that which has undergone digestion in ordinary septic tanks or in Imhoff tanks; but with the type of separate digestion tanks thus far used, the removal of the sludge from the tanks has not proved as easy as with Imhoff tanks, and in some instances it has been found difficult (with separate digestion tanks) to bring about a satisfactory digestion of the sludge.

Small scale tests with a separate sludge digestion tank at the Philadelphia Sewage Testing Station gave disappointing results, as may be seen by reference to page 171 of the report, where the opinion is expressed that "the placing of sludge in open water-tight tanks is not an advantageous means of disposal." In these tests fresh sludge was added to the digestion tank every two weeks, and although there was some gas formation and liquefication during the first part of the test, this ceased altogether with cold weather, which may be explained in part by the fact that the tank was quite shallow. It is said that the tank always had a thick scum and that there was no material change in the character of the underlying sludge.

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* Of Hering & Gregory, Consulting Engineers, New York.

* Handbuch der Hygiene, II. Band, 2. Abteilung, Wasser und Abwasser.

The excess liquid which overflows from separate digestion tanks will be of a peculiarly objectionable character and must be purified. If discharged back into the settling tank it would tend to make the sewage septic, and in any case presents a difficult problem for solution.

The sludge as discharged into separate digestion tanks will always contain some sewage having undecomposed organic matter in solution, so that the process of digestion is likely to be somewhat similar to that occurring in ordinary septic tanks, with consequent probability of the production of objectionable odors. These odors, as pointed out by Mr. Pearse, are likely to be especially noticeable at times when the sludge is being discharged into the digestion tanks, for the reason that the sludge, having already begun to decompose, contains foul-smelling gases which, due to the stirring up of the sludge, will escape. The separate sludge digestion tank at the Chicago Testing Station is said to have produced a very noticeable putrid smell, and engineers who have inspected, during warm weather, the operation of the separate sludge digestion tanks at Forest Park, Baltimore, report somewhat similar conditions.

Another point of importance in this connection is that such separate digestion tanks as have been built have a larger surface of liquid exposed to the atmosphere than is the case with Imhoff tanks, and may thereby give a greater opportunity for objectionable odors to become noticeable.

In Birmingham, England, where sludge from septic tanks was deposited to a depth of 5 or 6 ft. in large open lagoons, Mr. Watson stated that a thick, strong crust was formed on the surface, beneath which the sludge remained in its original condition, with no apparent loss in amount, and continued to give off foul odors irrespective of the age or density of the deposits. It would no doubt be possible to mention other instances in which separate tanks have not been successful in bringing about a satisfactory digestion of the sludge. It should be stated here, however, that experiments now being made in Birmingham under Mr. Watson's direction indicate that separate sludge digestion tanks, when operating with Birmingham sludge under certain conditions, can be made to give a well-digested sludge.

The effect of this method of sludge treatment on the flowing sewage is likewise a matter of considerable importance. If the sludge is removed from the settling tank under water this must be done at frequent intervals (say a week or sometimes even less in warm weather), in order to prevent a partial decomposition of the organic matter in the sludge previous to its removal from the settling tank. Such partial decomposition in the settling tank, by stirring up the deposits, interferes with the settling action and has the effect of making the sewage septic. This may lead to the production of objectionable odors around the settling tank. Unless the sewage, as well as the sludge, is removed at intervals from the settling tank and the entire tank thoroughly cleaned, there is pretty sure to be trouble of the above-mentioned variety, as it is difficult, even with specially designed tanks, to remove from the settling tank under water all of the sludge.

The second point of importance to keep in mind is whether the digestion of the sludge can be effected as quickly in separate tanks as in Imhoff tanks. If the digestion is slower the tanks must be larger, which, with this method of treatment, is an important factor to be considered, as it is necessary to have two distinct sets of tanks.

The digestion of sewage sludge is a biological process and without doubt proceeds rapidly only when the environment has been made suitable for the particular kind of bacteria which do the work, and when other unnecessary types of bacteria are so far as possible excluded. The creation of the proper environment requires time, and after the environment has once been created it is desirable, just as with a sprinkling filter, to have the food supply, in this instance consisting of sludge particles, enter the tank in a continuous stream and at a uniform rate. This is not easy to arrange with separate sludge digestion tanks. Consequently every time a new supply of sludge is added to the tank "the balance" of the bacterial activities is upset, partly because the newly added sludge, including some sewage and numerous varieties of bacteria, constitutes such a large proportion of the total contents of the tank.

In many of the separate digestion tanks thus far operated no provision has been made for having, above the sludge deposits, a considerable depth and volume of water in which the sludge can be kept, by the rising gases, in a more or less continuous state of motion. The bacterial toxins can, therefore, not escape easily nor are fresh sludge surfaces exposed to bacterial action as frequently as desirable, all of which tends to check the rapidity of digestion.

To sum up, it seems probable that although separate sludge digestion tanks can be made to give sludge of a satisfactory quality, the time required for complete digestion is nevertheless likely to be longer than with tanks of the Imhoff type, thus calling for larger tanks. There is also a greater possibility of the production of objectionable odors.

The cost of operating separate sludge digestion tanks is in most instances likely to be higher than with the type of tank which includes both a settling chamber and a sludge digestion chamber. In the first place, as already pointed out, the best results with respect to the effect on the sewage itself can be obtained only when the settling tank is completely emptied and cleaned at regular intervals. Secondly, it is questionable whether fresh sludge can be removed as easily under water as completely digested sludge. Furthermore, the removal of sludge from one tank to another always involves loss of head and in many instances may necessitate pumping. Finally, the removal of sludge from some separate sludge digestion tanks, even after more or less complete digestion, has been found to be a slow and expensive process.

At the small disposal works in Forest Park, Baltimore, for example, the writer saw four men at work shoveling the digested sludge out of the tank. In cases where this method of removal has to be adopted the construction of an extra tank may be necessary, since one tank will be out of commission much of the time. The necessity for purifying the liquid which overflows from the separate digestion tanks has already been stated in detail.

Although separate sludge digestion tanks have certain disadvantages, their adoption under some conditions may prove desirable. In such cases it would be advantageous to make the tanks as deep as possible, so that the digested sludge when removed will have a comparatively low water content and contain a part of the gases of decomposition. When first placed in operation it would be desirable to fill the tanks with clean water, which contains no easily decomposable organic matter. This procedure will tend to lessen the production of odors, particularly during the "ripening time." The fresh sludge should be discharged into the tank at regular intervals and in comparatively small quantities, so that the amount of sewage accompanying the sludge will be small in comparison with the whole body of liquid in the tank, and will, therefore, not tend to make this liquid odorous.

The tanks ought never to be completely emptied, as it will then be necessary for them to pass once more through the ripening time. If the gas developed does not prove sufficient to keep the sludge well stirred up so that new surfaces are constantly being exposed to the action of the bacteria, it may be possible to add certain cellulose sub-

stances which will increase the gas formation, or to stir the sludge artificially, with a paddle, with compressed air, or with clean water. In case water is used for this purpose there would be an overflow from the tank which would probably require purification.

It is to be hoped that those who have had experience with, or knowledge of, the operation of separate sludge digestion tanks will contribute to a discussion of their relative advantages or disadvantages so that, before forming definite opinions, engineers may have the benefit of as many as possible of the available data.

THE DIESEL OIL ENGINE.

Since its commercial introduction in 1897 this engine has steadily worked its way into the foremost ranks of motive power producers and is to-day considered to be the most perfect piece of mechanical construction for transforming the heat energy in oil fuel into mechanical energy; the thermal energy being about 48% with an effective or brake energy of 35%.

Aside from its enormous output the engine has a great commercial importance in its ability to utilize low grade oils in addition to pure petroleum, as tar oils, and oils produced from the distillation of shale and lignite will operate the engine under satisfactory conditions.

A further reason for the prominence given this engine lies in the fact that it has broken the monopoly of coal. At the Turin Exhibition, last year, a steam turbine and a large Diesel engine, both made by Franco Tosi, of Milan, and set up on the same stand, were worked together with the same liquid fuel. The boilers furnishing steam to the turbine

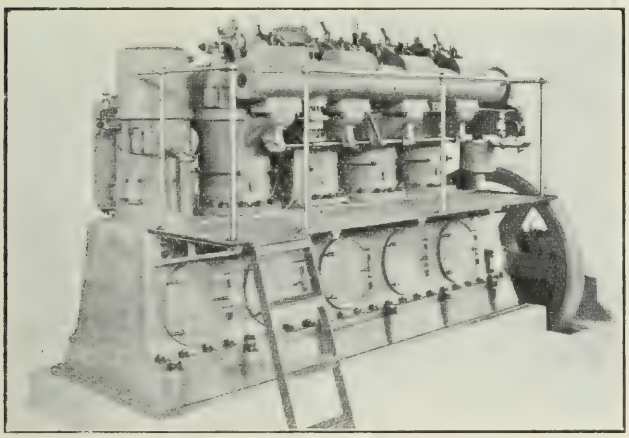

Fig. 1.—View of Engines of the "Selandia."

burned crude oil. The difference between the two plants was therefore this: for the working of the steam engine the whole boiler plant with its chimney, fuel-supply apparatus, purification plant for feed water with feed pumps, extensive steam pipes, condensation plant with water pumps and an enormous water consumption, had to be provided, with the final result of consuming 2½ or more times the fuel per horse-power required by the Diesel engine standing beside it. The latter, being an entirely independent engine without any auxiliary plant, took up its crude fuel automatically and consumed it direct in its cylinders without any residue or smoke. A better proof can hardly be imagined, even for the non-technical man, that except in special cases the steam engine cannot compete economically with the oil engine. It is hardly possible for a country which produces no coal, like Italy, to develop a great industry based on the steam engine, and this is one reason for the exhibition at Turin of about thirty Diesel engines of various types and sizes, and made in different countries.

Thus the Diesel engine has doubled the resources of mankind as regards power-production, and has made new and hitherto unutilized products of nature available for motive power. The Diesel engine has thereby exercised a far-reaching influence on the liquid-fuel industry. It has been proved by recent geological researches not only that there is probably on the globe as much, or perhaps even more liquid fuel than coal, but also that it is more conveniently distributed as regards its geographical position.

Although the engine has been used to a considerable extent for power-house and factory purposes, it is the prominence given it through its adaption to marine and naval propulsion that has brought the engine so prominently before the public. The first oil propelled liner of large dimensions to be a commercial success was the "Selandia" of the East Asiatic Company, a ship of 9,800 tons displacement and was built by Messrs. Burmeister and Wain, Copenhagen, there are two engines, driving twin screws, each engine consisting of a set of eight single-acting cylinders 20⅞ in. in diameter by 28¾ in. stroke, working on the four-stroke cycle. Messrs. Burmeister and Wain have adopted this type of Diesel engine to obtain greater reliability, owing to the absence of temperature troubles, the completeness of scavenging, and the better balance of the reciprocating parts than has so far been considered obtainable with two-stroke cycle engines of equal power and of the same cylinder dimensions. That this policy is justified was proved by the running of the engines on the demonstration trip from London to Antwerp.

The cam-shaft and manœuvring-shaft are supported on brackets bolted to the crank-case, making the removal of the cylinder-heads for the examination and adjustment of the reciprocating parts quite simple, as neither of these two shafts need be disturbed in any way. Skew-gearing—the most general method of drive for the cam-shaft—has in this design been displaced by cast-steel spur-wheels, although it is retained for the manœuvring-shaft, which is only in action to bring the opposite motion cams into play, to lift the rollers with their push-rods and to replace them. The skew-gearing is operated by a compressed-air motor taking air from the starting air reservoirs. There are two fuel-pumps for each set of eight cylinders, each pump being of sufficient capacity to supply the whole engine, and, according to the gauge, the pressure of the oil on the exit from the pump was 1000 lb. per sq. in. This gives an indication of the extreme accuracy of machining and fitting which is essential for this work.

With regard to the auxiliary and machinery for the main engines, it is quite evident that no pains and no expense have been spared to render this plant as immune from break-down as is possible. Hitherto it has been with the compressed-air plant that the difficulties have been experienced, causing break-downs and necessitating in several ships the fitting, after completion, of a donkey boiler to supply steam to ensure the reliable working of the auxiliaries. On the Selandia the compressed air for starting and for fuel injection is supplied from the two three-stage 300 lb. per sq. in. compressors driven by the Diesel engines, which are also coupled to the generators for the electric power. In the next ship by these builders it will be so arranged that each set will be equal to the total normal work, so that even if one set were to break down, the maximum speed of the vessel would be maintained. A fourth-stage compressor in the forward end of each main engine receives the air from the 300-lb. com-

pressor, and compresses it up to the pressure required for the injection and pulverization of the fuel—i.e., 900 lb. per sq. in. Each of these high-pressure compressors is equal to the total work of both engines, and, further, an additional length of working stroke can be given to either when it is desired to increase the output of 900 lb. per sq. in. air for the recharging of bottles, &c. It is also further possible to fit a delivery valve with connections to a working cylinder in place of the exhaust valve, so as to augment further the store of the starting medium, by utilizing the compression stroke of the cylinder. The engine turns well, and without appreciable loss of balance when firing in seven or even six of the cylinders of one engine. As a final stand-by, a steam-driven three-stage 900 lb. per sq. in. air-compressor is installed forward of the oil-fired donkey boiler which is placed aft in the engine-room between the thrust shafts.

The fuel injection air is stored in two working bottles of German manufacture, with solid ends welded in by a patent process, placed vertically amidships between the compressed-air manœuvring engines. Drain-pipes to the bottom of the working bottles are fitted, and periodic blowing down ensures freedom from moisture, with its consequent corrosion. Two spare bottles are placed against the forward bulkhead, and it is so arranged that connections can be made between the independent fuel-injectors, one working and two spare air-bottles, to keep the main engines running should their air supply fail, due to leakage, &c. It is interesting to note that both the auxiliary Diesel engines have also a fourth-stage air-compressor (300 lb. to 900 lb. per sq. in.), on the forward end of their crank shafts. The starting air, at 300 lb. per sq. in, is stored in four reservoirs—two for each engine—with dished ends, which are hung from the deck above. One reservoir is normally sufficient for each engine.

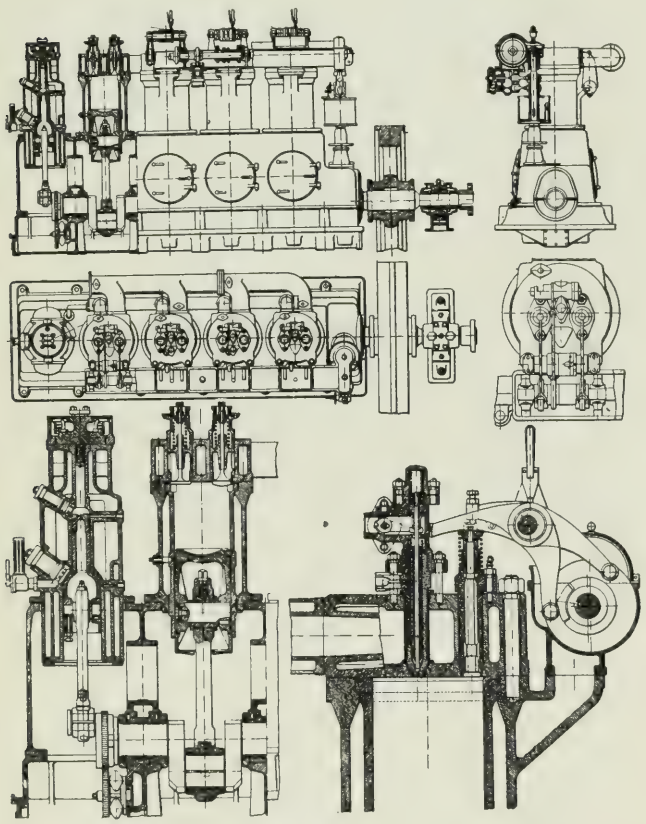

Fig 2.—Details of 200 Horse-power Four-cycle Diesel Engine.

Lubrication oil to the main bearings is forced in at 10 lb. per sq. in. pressure by one of two electrically driven plunger pumps through the main bearings, crank-shaft, and crank-webs to the pin and bottom end bearing, thence up the connecting-rod to the crosshead bearing, and up the piston-rod to the piston, coming down the piston-rod again to the guides, when the oil is partially cooled, and thence led outside the crank-case and discharged through a filter to the sump in the bed-plate. This discharge supplies the means whereby the engineer on watch can assure himself of the quantity of flow and the temperature of the oil. Each lubricating oil-pump is in circuit with a cooler of ample proportions to cope fully with the onerous temperature conditions of the Red Sea and the tropics. There are two cooling-water centrifugal pumps, electrically driven, to supply all the cooling for the main and auxiliary engines, main and auxiliary compressors, lubricating oil, &c.; two duplicate electrically-driven three-throw plunger-pumps, one for sanitary purposes, two for the bilges, with connections to the ballast tanks, which are usually pumped out by a compressed-air-driven ballast pump. The compressed air also operates the fuel-oil pumps, which draw the fuel-oil from the double-bottom tanks to two daily service tanks of sufficient capacity for 12 hours' working, which are placed on the engine-room tops. The function of these service tanks is to permit of the settlement of any water pumped, together with the oil from the double-bottom tanks, which are filled with ballast when empty.

It is claimed that the adoption of Diesel engines has increased the cargo-carrying capacity by 1,000 tons, chiefly owing to the absence of coal-bunkers, since an engine and boiler room for the same power would only occupy two or three frame spaces more than the Diesel engines. The saving in weight must be small, since the machinery of the Selandia must weigh some 400 to 450 tons, which is equal to 250 lb. per brake-horse-power for the main engines alone.

Details and views of the engine are shown in Fig. 2. This shows the mechanical make up of the engine which is a good example of a modern Diesel engine.

NEW DEVICE FOR LAUNCHING LIFEBOATS.

Sir Bryan Leighton has invented a new device for launching lifeboats, and a model of the contrivance has recently been shown at the Hotel Cecil, London. The idea is to launch lifeboats from both sides of the ship by an apparatus on the water-shoot system. The end of the shoot or launching way rests on a pontoon, which in the case of a ship of the dimensions of the Olympic would be 40 feet long, 8 feet deep, and 10 feet wide. A ship of the size of the Olympic would carry two of these launching ways, one on either side. They are attached to the side of the ship by means of a swivel, and lowered by a crane which swings them free of the ship into the water. The passengers enter the boats on the deck. The boats are run along a set of rails to a turning table immediately at the top of the shoot, and are lowered down to the water level by means of a wire hawser. Towards the end of the shoot is a knuckle, which causes the bow of the lifeboat to have a tendency to shoot upwards on touching the water. The launching way can be placed at an angle, according to the state of the sea. It is assumed that an experienced seaman is placed in each boat, and directly he gets within a couple of boat-lengths of the water he manipulates the releasing apparatus; the boat then shoots into the sea, and the rope is pulled up for another boat.

A Board of Trade expert spent an hour in examining the device, and did not offer any serious objection to it. The inventor claims that it is a simple and inexpensive contrivance, and it is understood that it will be brought before the notice of the leading shipping lines.

AN IMPROVED CONCRETE PAVEMENT.*

By Mr. E. W. Groves, City Engineer, Ann Arbor, Mich.

Some years ago the writer became convinced that the forms of street pavement commonly used were too expensive to come into general use, especially on residence streets, in both our large and small cities and on country highways. If the demands of modern traffic were to be satisfied, a much cheaper form of pavement must be devised, yet one having all the essential characteristics of permanency and low cost of maintenance. With this idea in view, concrete pavements, constructed in the ordinary manner, were inspected and it was found that while the concrete had the strength to support the weight imposed upon it, it was readily susceptible to the abrasive action of traffic as well as to changes in volume, which produced cracks, which in turn, under the action of wheels and hoofs, soon became enlarged into ruts. Previous to this inspection the writer had caused a section of a street paved with asphalt blocks, which was rapidly disintegrating, to be covered with a thin coating of crude coal tar and sand. The effect was wonderful. The new coating took all of the wear which had formerly been on the asphalt blocks and preserved the pavement, which is in good condition to-day. The pavement is less noisy than before, and not as slippery as sheet asphalt.

For some time the citizens living on a certain block in this city had desired that it be paved. But they were unwilling to pay such high prices as had been charged for pavement. In an effort to satisfy their request the writer conceived the idea of laying a concrete pavement and covering it with a coating of tar and sand. Accordingly, with the consent of the city authorities and the property owners, we paved one block, of 1,883 sq. yds., with concrete, covering the surface with hot crude coal tar and sand, using about one-half gallon of tar to each square yard of pavement. After this pavement had passed through the winter of 1909 and 1910 and our citizens had an opportunity to judge its merits, petitions were presented asking for over 20,000 sq. yds., which were laid during the summer of 1910. During the winter and spring of 1910 and 1911 petitions were presented asking for about 70,000 sq. yards., of which 64,000 sq. yds. were laid and at the present time we have on file petitions asking for 140,000 sq. yds. more, which will be laid as soon as conditions are favorable.

Let us return to the subject of the change of volume of concrete. The writer, of course, was aware that such a change occurred. He had his ideas, as all of you have. But it remained for Prof. A. H. White, of the University of Michigan, to tell us the reason for the greatest volume-change. In a paper read before the American Society for Testing Materials and published in their Proceedings, Vol. XI., 1911, Prof. White gave the results of certain experiments performed by him. In his introduction he speaks of the "Constancy of volume" of cement mortars and calls it a "misnomer." Any one can see from cracked walls, sidewalks and other concrete structures, whose failure is not due to the settling of foundations, that there is some inherent characteristic which causes cement, cement mortars, and concrete to change volume if exposed to the weather.

He says: "The change of volume of concrete due to changes in temperature has been determined with considerable accuracy to be per unit length 0.0000055† or 0.00055 per cent. per degree Fah. There are, however, other changes due to the chemical process of setting and hardening which are barely mentioned in even the more important treatises and other variations due to the wetting and drying of the concrete, whose very existence is practically unknown."

He deals with these latter and previously unknown changes. From earlier experiments by Schuman, Gary, Considere, and Campbell and White it was definitely determined that neat cements, hardening under water, expand at a decreasing rate for years, and that neat cements, hardening in air, contract similarly, and that cement-sand mortars act in the same manner as neat cement, but to a less degree.

Mr. White has been experimenting for twelve years or so with neat cements and various sand mortars. He has found that neat cement, when immersed in water for a period of three years, showed a linear expansion of from 0.10 to 0.15 per cent., nearly all of which occurred during the first year. When these bars were allowed to dry in the room (temperature about 70 degrees Fah.) for 65 days they had contracted to their original volume and in some cases 0.05 per cent. less. Upon re-immersion in water they regained all their previous expansion in about one day, and some expanded more than they had ever done before. In one specimen of natural rock cement the expansion in water during the same period of time and under the same conditions went as high as 0.55 per cent., but on drying contracted +0.25 per cent. He also tested in the same manner various

View of Street in Ann Arbor, Mich.

bars composed of a 1:3 mix of sand mortar and compound bars of neat cement and 1:3 mix. The first bars behaved like the neat cement, only in a less marked degree. In the compound bars the neat cement part acted in the same manner and in the same degree as the other neat cement bars, while in the 1:3 mix there was a tendency to lag in both expansion and contraction. This difference of expansion, of course, set up sheering stresses at or near the line of demarcation. In some cases these sheering stresses were great enough to rupture the bars.

To take some examples of this from actual practice, the writer can site numerous cases in Ann Arbor where the sidewalks have broken apart, that is, the top course broken loose from the bottom course, and in every instance it could be seen that the line of fracture did not conform to the line of demarcation, but was below in the leaner mix. There was a film of the base concrete from 1/64 to ⅛ and in some cases ½ of an inch thickness clinging to the top course, showing that the failure was not due to poor bonding between the two courses. Doubtless every one of you have seen a sidewalk buckle up in an inverted V. This

* Presented at the Eighth Annual Convention of the National Association of Cement Users, Philadelphia, Pa.

† Pence, Eng. News, Vol. 46, 1901, p. 380.

occured in some of the walks on the campus of the University of Michigan, and on several of the city streets in walks that have been laid from one to ten years. The peculiar thing about the failure was that it occured during the summer months, thus precluding any result of the frost action. There remains only the moisture to blame, since the expansion due to heat is so small. To the writer's mind the foregoing proves conclusively that the great destruction of concrete pavements is due, first and foremost, to the alternate wetting and drying when they are unprotected.

Now, this coating of bitumen and sand is waterproof. Thus the greatest cause of the destruction of concrete pavement is eliminated. The writer does not care to go into the question of water from below or sub-drainage. The greater portion of the streets of the city of Ann Arbor are of a gravelly soil and thus drain themselves. However, a portion of one street is clay and the pavement was laid directly upon it, and shows no ill effect up to the present time, and none is expected.

The pavements laid during the seasons of 1909 and 1910 were trated with crude coal tar and, while this material was fairly satisfactory, it was evident that a distilled product having a uniform consistency would be better. Experiments were made with various products of the distilled tar, tarvia, and asphalts with various degrees of viscocity. These were all more or less unsatisfactory, more especially the products containing asphalt oils. As objectionable features made their appearance efforts were made to overcome them. Extensive laboratory tests produced a bitumen which has none of the objectionable features of the crude tar, tarvia and asphalt. This bitumen, when applied to the concrete at a temperature of 180 degrees Fah., is thin enough to bond into the interstices of the base, making an impervious surface.

The pavements laid up to the present time have been made up of two layers of concrete, viz.: a base 4½ inches thick composed of one part of cement to eight parts of bank run gravel, and top layer 1½ inches thick composed of one part of cement to two parts of gravel passed through a screen having a one inch mesh, the cop course being applied immediately after the bottom course is laid to insure a good bond. Since the top coat of a pavement laid in this manner contains more cement than the bottom, and since it has been shown that such a construction tends to produce internal shearing stresses; there is a possibility of separation of the two layers. While no action of this nature is apparent in our pavements, due to the waterproofing effect of the bitumen, to be on the safe side, all our future work will be one coat work, using approximately one part of cement to 4½ parts of bank run gravel.

It has been the practice to leave an expansion joint about ¾ of an inch wide at each curb, and also every 25 ft. transversely of the street. After the surface of the concrete has been trowled to conform to the crown of the street, and when it is partially set, a light wire broom is used to roughen it in order to furnish a better surface for the adhesion of the bitumen. Later the expansion joints are filled to a little less than one inch of the surface, with sand upon which is poured hot bitumen, making the joint filling flush with the surface of the concrete. After the concrete has become thoroughly set and is dry and clean (being swept if necessary) one half gallon of bitumen heated to a temperature of 180 degrees Fah. is spread over each sq. yd. of the surface of the pavement, and while this bitumen is still hot and soft it is covered with a layer of torpedo sand ranging from ⅛ to ¼ inch, using about one cubic yard to each 250 sq. yds. of pavement. The street is then immediately opened to traffic which grinds the sand into the bitumen and products a rubbery surface, black in color, almost noiseless, and having the appearance of sheet asphalt.

As to the cost of maintenance, I can only speak from an experience of three years. With upwards of 80,000 sq. yds. of this pavement, constructed during the last three years, not to exceed $30.00 has been expended on repairs, and the pavement is in good condition to-day. The owner of a frame house, in building, does not consider that the first painting will last the life of the house. He plans for the expense of repainting every few years. Its initial cost is low enough to allow for maintenance charges. It must be kept in mind that there is no pavement that is entirely free from maintenance charges. In summing up the advantages of this pavement, it may be said that the concrete, if properly and honestly constructed, is strong enough to sustain the weight of the traffic which passes over it. The bitumen prevents the absorption of water by the concrete and thus preserves it from cracking. The change of volume due to temperature is negligible. The combination of torpedo sand and bitumen gives a wearing surface which is unexcelled. The construction cost is low as compared with other pavements and requires no cumbersome and extensive plant. When it becomes necessary to put pipes of any sort beneath the pavement repairs are easily and perfectly made, no ridges or hollows being produced. With a firm sub-base no reinforcement whatever is necessary for the stability of the pavement. With the manner of filling the expansion joints described above, there is no chipping or crushing of the concrete at the edges. If the filling is carefully done it is impossible to point out an expansion joint in the finished street. When the hot sun of summer heats the pavement there is absolutely no free bitumen coming through and sticking to the feet. It does not "bleed." Our citizens are so well satisfied with it that they will not consider any other form of pavement. It is, indeed, a most suitable pavement for country highways, parks and boulevards, as well as city streets. With gravel banks, ledges of rock, marl clay and sand, the essential elements of concrete so profusely distributed throughout this country, the bitumen easily obtained, a pavement that can be laid for about one dollar a square yard based on Ann Arbor prices, and that is durable, noiseless, and pleasing to the eye, I can see no reason why it should not become the most universally used of any or all of the various pavements before the people to-day.

LARGE WATERWORKS.

The protracted negotiations between the governments of South Australia, Victoria and New South Wales in regard to the proper utilization of the waters of the River Murray for navigation and irrigation have been advanced another stage, an agreement authorizing South Australia to construct storage works at Lake Victoria having been signed by the premiers of the three states concerned. Lake Victoria is situated in New South Wales, and about 14 miles in a direct line above the boundary of South Australia.

The agreement, which is subject to ratification by the parliaments of the three states, contains provisions for the transfer of the site of the proposed works from New South Wales to South Australia. It is estimated that the reservoir which will result from the improvement of the present Lake Victoria will have a storage capacity of 1,500,000,000 cubic feet, and it will approximately cover an area of 30,000 acres. There will be two weirs and locks associated with the reservoir, the exact sites of which are not yet determined. A clause in the agreement provides that the compact shall not be regarded as a settlement of the vexed question of the apportionment between the states of the waters of the Murray.

TESTS ON REINFORCED-CONCRETE BEAMS.

The Structural Materials Laboratory of the United States Geological Survey was founded at St. Louis, Mo., in 1904, in connection with the world's fair being held there at that time. At this laboratory there was carried on for six years extensive tests of various structural materials, including a number upon various kinds of concrete and reinforced-concrete specimens. The scheme of the laboratory in these latter tests was to proceed from the simplest forms of cement, mortar and concrete through concrete tension and compression tests to various reinforced-concrete beams and columns. In July, 1910, by act of Congress the laboratory was transferred from St. Louis to Pittsburg and from the direction of the Geological Survey to the United States Bureau of Standards, under whose auspices further work will be carried on. Preliminary reports of the tests on concrete materials include Bulletin No. 331 of the U.S. Geological Survey, which describes the tests of Portland cement mortars and their constituent materials, and Bulletin No. 344 of the U.S. Geological Survey, which covers the tests of plain concrete beams. The next step in the testing, that is the test of plain reinforced-concrete beams, was completed at the St. Louis laboratory, but the data for the test were transferred to the U.S. Bureau of Standards when the laboratory was transferred and have been just published by that bureau as a "technologic paper." We give below a short description of its contents.

The tests comprise simultaneous compression tests on 8 x 16-in. cylinders and 6-in. cubes and simply reinforced beams with varying percentages of reinforcement. The series consisted of 336 beams (three of which were not tested) together with the corresponding cylindrical and cubical test pieces for compression tests and 48 bond test pieces to determine the adhesive strength of the aggregates used. Representative material of four classes of aggregate, gravel, crushed granite, crushed limestone and cinders, were used in making up the test pieces which were tested in triplicate at the ages of 4, 13, 26 and 52 weeks, respectively. The report says:

The report of these tests has been confined exclusively to a presentation of test data in such a way as to indicate with considerable certainty the various elements which affect the design of architectural and engineering structures. Studies have, therefore, been made near maximum load between external load conditions, as measured by the bending moment, and resistance of the beam as determined by the resisting moment. There is included the relation between the unit stress at maximum load and the yield point of the reinforcement.

Studies have been made for maximum load and for unit stresses of 16,000 and 32,000 lb. of the relation between the effective percentage of reinforcement and (1) the resistance $\frac{M}{bd^2}$ of the beam as measured by ——, (2) percentage depth to the neutral axis, (3) unit compressive stress in the extreme upper fibre, (4) the deflection at the centre of the beam. The results are presented diagrammatically and in greater detail in tabular form. The change of such relation with age and the difference due to the nature of the aggregate have also been determined and are presented.

The development and spacing of the tension cracks below the neutral axis for the various aggregates, ages, and percentages of reinforcement is plainly shown by photographs of the beams.

There is also included a study of plain concrete in direct compression. The growth in strength with age and the increase in stiffness, as measured by the initial modulus of elasticity, are clearly brought out. The variation with age of the ratio of the yield point to the ultimate strength for the different aggregates has been determined.

No extended discussion of the theory of reinforced concrete is attempted in this bulletin, and theoretic formulas have been introduced only where necessary for the intelligent presentation of the data. The formulas used are, however, not original with the bulletin, but are based on assumption which are thought to approximate the truth.

The preliminary description includes accounts of the methods of tests of the cement, the sand, the aggregates, the reinforcement and the separate test pieces. Following that is a chapter on the result of tests, which discusses the tables which include all the data of the tests and in addition takes up the analysis of the beam at the first crack, the analysis at maximum load and the effect of variations in the percentage of reinforcement. Finally, in this portion is a discussion of the compression tests, taking up the influence of age on relative strength of cubes and cylinders and upon the modulus of elasticity and yield point and the ratio of the yield point to the ultimate strength.

The variation in the constants entering into the composition of the beam and the completeness of the record of the tests are such that a great number of tables and diagrams are needed to present the results. At the same time, these results are most comprehensive and permit of a thorough study of the behavior of simple reinforced-concrete beams.

Conclusions.—As a result of the tests, the authors have made the following conclusions:

Reinforced Concrete in Flexure.—The unit elongation of the extreme lower fiber at the time of the occurrence of the first crack is 0.00012, for stone and gravel concrete, 0.00018 for cinder concrete, and equals the unit elongation of the lower fiber at rupture of a beam of the same concrete without reinforcement.

The unit elongation of the extreme lower fiber at time of the occurrence of the first visible crack increases with the percentage of reinforcement.

The distance between cracks due to tension varies with the percentage of the reinforcement, slightly with the kind of aggregate, and is independent of the age of the concrete.

The ratio of the unit stress in the reinforcement at maximum load to the yield point varies with the percentage of the reinforcement, is independent of the age of the concrete, and shows no regular variation with the initial modulus of elasticity of the concrete.

The unit bond stress at a load just below maximum, for a unit stress in the reinforcement somewhat less than the yield point, is almost constant and equal to about 120 lb. per sq. in. It increases slightly as the percentage of the reinforcement increases, increases somewhat with age, and with the strength of the concrete.

Basing the resisting moment of a reinforced-concrete beam on the tensile stress in the reinforcement, and neglecting the tensile resistance of the concrete, the ratio of the resisting moment to the bending moment is always less than one between 0.5 per cent. and 1.7 per cent. "effective" reinforcement. This ratio is independent of the kind of aggregate used, decreases with age, and increases with the percentage of reinforcement.

The behavior of the reinforced-concrete beam, having the reinforcement in two horizontal planes is identical with a beam having all the reinforcement concentrated in one plane, and equal in amount to the reinforcement in the lower plane plus that in the upper plane multiplied by the ratio of the distances of the upper and lower planes from the neutral axis.

The percentage depth of the neutral axis below the top of the beam increases with the percentage of reinforcement and increases or decreases with different amounts of reinforcement as the intensity of loading increases, depending upon the ultimate strength of the concrete as influencing a compression failure, and the relative stiffness of the concrete for varying degrees of stress as determined by the character of the stress deformation diagram of the cylinders (fixed by the proportions, consistency, kind and age of concrete).

For all practical purposes the percentage depth to the neutral axis for a given unit stress in the reinforcement may be taken as independent of the age of the concrete.

The character of the concrete as measured by its modulus of elasticity exerts an influence on the position of the neutral axis.

For any given percentage of effective reinforcement the moment of resistance varies as the ordinates of a straight line, and based on the moment of resistance of a plain concrete beam the moment of resistance for a reinforced-concrete beam is proportional to the effective percentage of reinforcement.

The moment of resistance is appreciably affected by the character of the aggregate used and the age of the concrete.

For a given unit stress in the reinforcement the deflection increases with the percentage of "effective" reinforcement and increases as the modulus of elasticity and ultimate strength of the concrete decreases.

The deflection of a reinforced-concrete beam increases in direct proportion to the increase in the unit stress in the reinforcement.

The unit compressive stress in the extreme upper fiber varies with the percentage of effective reinforcement as the ordinates to a straight line.

Excepting cinder concrete for the earlier ages and low percentages of effective reinforcement, the unit stress of 16,000 lb. per sq. in. in the reinforcement corresponds to a unit compressive stress in the extreme upper fiber of at least 1,000 lb. per sq. in.

Concrete in Compression.—The conclusions as to the general effect of age on the various elements (ultimate strength, initial modulus of elasticity, and yield point) that determine the value of a given concrete are probably of fairly general application.

It should be recognized that the results obtained for each class of material—i.e., granites, limestones, gravels, etc.—used in these tests may not be applicable to other materials of the same class obtained from a different source. There are too many elements affecting the strength of concrete to warrant the assertion that because an individual of a class—i.e., granite—gives excellent results, that, therefore, all granites will give equally good results. The gravel used in these tests has smooth, round surfaces but developed a compressive strength but little inferior to that of the granite, and appreciably greater than that of the limestone. Yet it cannot be stated that the use of any given gravel for concrete is permissible, because this particular sample, which originated from a hard, flinty rock and is well graded, gives excellent results. A gravel deposit will necessarily partake of the physical properties of the rock from which it is derived and no good results can be hoped for by the use of a gravel which originated from a soft, chalky limestone or from some weak, cleavable shale or sandstone. The compressive strength of the stone affects the compressive strength of the concrete in which it is used in too great a degree to warrant the neglect of the consideration of this influence, while even for the same stone, the strength of the concrete will be greatly influenced by the uniformity or nonuniformity of the grading.

Again, for equally good grading, the material which grades down from the larger particles will nearly always show the greater strength. The effect of a large amount of dust in decreasing the strength of the concrete should not be overlooked. It must be recognized that the quality of the sand used in making the concrete—i.e., its hardness, size and grading, the presence of a large amount of very fine material—are all elements which will modify conclusions as to the excellence of a given stone or gravel.

From a consideration of the above facts it is always advisable to make careful investigation of the materials available, even though the costs of tests seem excessive.

The weight per cubic foot for a 1:2:4 stone and gravel concrete may be taken as 150 lb. and a cinder concrete 120 lb.

The ultimate strength of 2,000 lb. per sq. in. for a 1:2:4 concrete at the age of four weeks, frequently the basis for unit stresses, was exceeded by almost 50 per cent. for the granite and gravel and by 25 per cent. for the limestone concrete, but the value found was 20 per cent. less than 2,000 lb. per sq. in. for the cinder concrete.

The ultimate compressive strength of concrete shows a substantial increase from an age of four to one of 52 weeks, the strength at four weeks being about 65 per cent. of that of 52 weeks.

The yield point at the age of four weeks averages about 0.30 the ultimate strength and for stone and gravel concretes is well above 500 lb. per sq. in., but for cinders is somewhat less. The yield point shows a substantial increase with age.

The compressive stress, gross deformation diagram of concrete may be represented by a straight line up to a unit stress 1.5 times the yield point with a maximum error of about 6.5 per cent. A working formula for reinforced-concrete in flexure, based on a constant stress deformation diagram for concrete in compression, will therefore, give correct results up to an extreme unit fiber stress of 0.30, the ultimate strength. This would correspond to a factor of safety of about 3 and for a unit fiber stress 50 per cent. greater the error will not exceed 7 per cent.

The initial modulus of elasticity at the age of four weeks exceeds 2,500,000, the amount usually specified, by about 85 per cent. for gravel, 70 per cent. for granite, and 45 per cent. for limestone concrete, but is 35 per cent. less for cinder concrete. The increase in stiffness with age as measured by the modulus of elasticity, while marked, is not nearly so great as the increase in strength.

The ultimate strength of concrete in compression as given by the cylinder test is always less than that given by the cube test, the ratio being about 75 per cent. at the age of four weeks, and showing a substantial increase with age, due to the greater percentage increase of strength for the cylinders.

Reinforcement.—A study of the 1,260 tests of the steel used as reinforcement for the beams herein recorded shows that: (a) For even practically identical ultimate strengths there is considerable variation in the percentage of elongation and reduction of area. (b) The yield point bears no relation to the ultimate strength.

A NEW COMBINATION OF METALS.

A French metallurgist has manufactured an alloy with a hardness of steel and of great tensile strength by the addition to copper of chromium, aluminum, nickel and zinc at certain temperatures, which are maintained for specified lengths of time.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

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THE INTERNATIONAL CONGRESS OF NAVIGATION.

The twelfth session of the International Congress of Navigation met this year in Philadelphia, and the meeting has just closed. The members of the Congress are men engaged in, or interested in, matters connected with waterway improvement and maintenance, rivers, canals, harbors, and terminal works, and practically all countries of the world are represented. As the most of the work covered by such a body of men is work which comes under the control of the different Governments, a very large proportion of the members of the Congress are Government officers, and many of them were officially delegated to attend the Congress. For this reason, no doubt, and because of the importance of the men in attendance, the Dominion Government has requested the Canadian Society of Civil Engineers to act as hosts in the reception of a party of members of the Congress who are visiting the eastern portion of Canada this week. A party of members of the council of the society and representatives of the eastern branches met the delegation on their trip to Sault Ste. Marie yesterday, and are now accompanying the party on their trip down the Great Lakes to Quebec. The Dominion Government is to be congratulated on their move to entertain the members of this Congress, for they are a most important body of men. Their impressions of Canada, as obtained from this trip, will be most valuable to the country in the future. The Government must also be congratulated in choosing the Canadian Society of Civil Engineers to act as the official hosts on this occasion, for the members of the society are better equipped to present the interesting features of our inland system of navigation and our harbor equipment than any other body of men.

CANADIAN ELECTRICAL ASSOCIATION.

The Canadian Electrical Association are holding their annual meeting in Ottawa next week. A programme of the meeting will be found in this issue of *The Canadian Engineer*. Last year's convention, which was held at Niagara Falls, Ont., was one of the best meetings ever held by the society. The attendance was large, the papers were good, and there was a strong interest shown throughout the meeting. As is generally known, this association is now affiliated with the National Electric Light Association, the union being made about two years ago. Evidently it has been a good thing for the association, for a renewed interest has been developed which speaks well for the future. The objects of the Canadian Electrical Association are to advance the professional interest and knowledge of the members in the various branches of applied electricity by holding meetings for the reading and discussion of papers and general interchange of opinions, to foster friendly intercourse between the members, and to promote the commercial interests of members engaged in the sale of electric light, heat and power. The association in its aim does not conflict in any way with the other engineering societies of the Dominion, and serves in a very real way to develop a spirit of friendliness and cordiality among the members of the profession interested in that branch of engineering. No doubt this year's meeting at Ottawa will be well attended, and we wish for the association a most successful meeting.

THE PUBLIC HEALTH DEPARTMENT OF ONTARIO.

During the last session of the Provincial Legislature an Act was passed dividing Ontario into seven districts under the Public Health Department. While the exact boundaries of the various divisions have not as yet been announced, it is understood that this will soon be done, and that the appointment of the seven Public Officers who will be placed in charge will be made almost immediately. The Government is to be congratulated on having taken this move, and there is little question but that under the present Provincial Health Officer the work will be carried on most effectively. The work of the Department will be much more effective under the new régimé, for the heads of the different districts will be able to exercise a greater degree of supervision over the different elements and conditions which affect the public health question of the Province. No doubt the utmost care will be taken in choosing the district officers, for they must be men not only with a knowledge of the problems of sanitation, etc., with which they have to deal, but they must be men of considerable breadth of view. The engineering profession will watch the development of this department of governmental activity with considerable interest, for these new officers will be more or less intimately associated with the solution of many engineering problems.

CITY ENGINEER.

An anomalous condition has arisen with regard to the appointment of the Commissioner of Public Works at Toronto. Mr. R. C. Harris, an eminently capable man for the position, has received the appointment, and with it the title of City Engineer. Mr. Harris is not a technical man, never having had any engineering training or experience, yet it is claimed, in order to secure the maximum of service, it is necessary that he carry the designation of engineer. The acting City Engineer, Mr. Powell, must, therefore, handle all of the technical phases of the city's administration, and be, in fact, city engineer, but he will not be able to have the title. The term "engineer" begins to mean little when city councils can give it to those without training. If certain city statutes give the City Engineer specific powers and duties which, from his engineering training, he is best able to handle, it is decidedly a mistake to hand these powers and duties over to a non-technical man, who must depend for his engineering knowledge on a subordinate. It is unfair to the acting city engineer not to give him the title if he must carry the responsibilities and duties of the position.

EDITORIAL COMMENT.

The investigation into the collapse of the south wall of the Neilson building, which occurred a short time ago in Toronto, has been concluded, and the verdict of the coroner's inquest has been published. We had hoped to cover the whole question of the collapse in this week's issue of *The Canadian Engineer*. Unfortunately however, this has to be delayed until next week. In our issue of June 20th a résumé of the investigation and a full account of the whole affair will be given.

A new permanent pavement between Toronto and Hamilton is being advocated. A first-class highway connecting these cities would be of inestimable benefit to both, and would serve as an object lesson on the advantages to be obtained from good roads. Ontario is becoming so populous and the conditions of traffic on the highways are becoming so severe that more attention must be paid to the question of the permanency of the roadbed.

GENERAL NOTES.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for May, 1912:

	Depth in inches.	Departure from the average of twenty years.
Calgary, Alta.	1.40	—0.08
Edmonton, Alta.	2.30	+0.54
Swift Current, Sask.	3.40	+1.18
Winnipeg, Man.	3.60	+1.59
Port Stanley, Ont.	2.40	+1.01
Toronto, Ont.	5.92	+3.10
Parry Sound, Ont.	6.00	+2.95
Ottawa, Ont.	5.60	+3.08
Kingston, Ont.	5.70	+3.60
Montreal, Que.	5.10	+1.75
Quebec, Que.	6.90	+3.75
Chatham, N.B.	6.90	+4.08
Halifax, N.S.	6.30	+2.64
Victoria, B.C.	1.60	+0.34
Kamloops, B.C.	0.30	—0.73

LAND DRAINAGE BY PUMPING.

Drainage by means of pumps has been carried on in European countries for the last hundred years, and has been rapidly increasing in the United States during the last twenty-five years. Through such extensive experience, including numerous failures, a considerable amount of knowledge is now available on the subject of the proper arrangement and the requisite capacity of pumping plants.

Among the plantations along the Gulf of Mexico, pumping has been in vogue for a long period. In Illinois, although first tried about twenty years ago, little was accomplished prior to 1900, but by the spring of 1910 ten plants were in operation, covering a total area of about 85,000 acres. The greater part of the lowlands along the Illinois River have been already reclaimed in this manner, and, as the lands are in the heart of the corn belt and possess a heavy, rich black soil, their value has led to a greater activity in drainage reclamation in the immediate vicinity than has existed in most other portions of the country.

BRIDGE WILL BE USED BEFORE COMPLETION.

The municipal council of Winnipeg, in order to provide traffic facilities across Osborne Street with all possible speed, have offered a bonus of one thousand dollars to the contractors providing they have the three steel spans in place and a temporary planking by the evening of July 9th next.

SANITARY SURVEY OF THE OTTAWA RIVER.

In the seventeenth annual report of the Board of Health of the province of Quebec, Mr. James O. Meadows, the sanitary engineer for the board, gives a report on a sanitary survey of the Ottawa River. His report presents many matters of interest and has been published in a pamphlet form recently by the Provincial Government, for general distribution. We present herewith an abstract of Mr. Meadow's report.

This report of the sanitary condition of the Ottawa River was undertaken to study the river as a source of domestic water supply and its relations to public health, and the information contained is based upon results secured from analytical data recently completed and by analytical data which was available from previous local studies.

These studies relate to the potability of the domestic water supplies, in regard to their relation to sewage, refuse, and industrial wastes discharged into the river at points above those from which such water supplies are obtained. These questions have been further studied by the aid of vital statistics and typhoid fever data so as to obtain their relations to the public health.

The work has been confined to a study of the main river from a point above Pembroke to Montreal, and the main object has been to determine to what extent the Ottawa River is used as a source of public water supply.

The work is taken up under the following headings:

1. Conduct of investigation.

2. The Ottawa River. Information as to its area, length, population on water shed, and a description of its special features.

3. Results of investigations.

Summarized data in regard to the population using the Ottawa River as a water supply, for the discharge of sewage, and manufacturing waste. The character of Ottawa River water as indicated by analytical data, together with data on water purification and typhoid fever statistics.

4. Conclusions.

Table No. 1.—Monthly Discharge of Ottawa River at Chaudière Falls, Ottawa, for 1910.

Months	Max.	Min.	Mean
January	28,000	21,500	24,750
February	22,000	16,000	19,000
March	46,500	15,500	31,000
April	73,000	47,500	60,000
May	76,000	61,000	68,500
June	70,000	45,000	57,500
July	44,500	23,000	33,700
August	28,000	22,500	25,200
September	29,000	21,000	25,000
October	33,000	20,000	25,200
November	39,000	32,000	35,000
December	39,000	22,000	30,000

Conduct of Investigation.—To secure the analytical data necessary, two trips were made down the Ottawa River, from Pembroke to Montreal. The first trip was made during June, 1910, when the flow of the river was near its maximum, and the last trip was made during October, 1910, when the river was in its low stage. During these two trips the important municipalities were visited and information secured in regard to their sanitary improvements. Printed blanks were also sent out to the towns bordering the Ottawa River requesting information of a general character in regard to population, water works, and sewerage systems. The important manufacturing concerns discharging liquid waste into the river, were visited, and a rough estimate obtained as to the amount of waste discharged by these plants.

A bacteriological field outfit was taken along on the two trips made, the 20° C. Agar plates were put up soon after collection, thus insuring a much more accurate count than could be obtained had this work been done in the Laboratory. The work was done as prescribed in the standard methods of the A.P.H.A.

The remainder of the bacteriological work was done in the laboratory together with the necessary chemical work. The chemical work was limited to a determination of the physical and mineral characteristics of Ottawa River water, because it was realized that the polluting factors would not be gross, and that the bacteriological analyses would offer a more accurate gauge as to their presence or absence.

Table No. 2.—Approximate Discharge of the Ottawa River and its Tributaries at High and Low Periods.

Name of River	High C. F. S.		Low C. F. S.	
Upper Ottawa, above Montreal	June	67,500	September	5,000
Montreal River	"	17,000	"	800
Keepewa	"	13,000	"	600
Mattawa	May	2,500	"	200
Maganasibé	"	1,400	"	100
Du Moine	"	8,000	"	400
Sheehan	"	1,800	"	100
Petawawa	"	7,000	"	500
Indian	"	600	"	100
Black	"	7,000	"	400
Coulonge	"	20,000	"	500
Bonnechère	"	6,000	"	300
Madawaska	"	19,000	"	000
Mississippi	"	8,000	"	500
Carpe	"	600	"	20
Turo	"	300	"	50
Gatineau	"	55,000	"	4,500
Rideau	April	10,000	"	300
Little Blanche	May	600	"	50
Blanche	"	1,200	"	100
Du Lièvre	"	22,500	"	1,500
North Nation	"	4,500	"	300
South Nation	April	24,000	"	100
Salmon	May	400	"	150
Route	"	8,000	"	700
Calumet	"	8,0	"	50
Du Nord	"	1,000	"	250
La Graisse	April	6,200	"	...
Outflow Lake of Two Mountains	May	250,000	"	17,400

Information was secured regarding the quality of public water supplies taken from the Ottawa River, especially in those places where local conditions play an important part as to the sanitary quality of the supply.

Considerable interest was shown by the municipal officials, after the purpose of the survey was explained to them, and the work was greatly benefitted by their co-operation.

Population statistics have been based on local estimates and will probably be found nearly correct. The census of 1911 will be at hand soon so that slight corrections can be made where found necessary.

Vital statistics have been obtained in the most part from the Ontario Board of Health and from the Quebec Board of Health. In the case of some of the larger cities typhoid fever statistics have been secured from the local Boards of Health.

Data as to water consumption are based on local estimates, and as a majority of the supplies are unmetered, it is very probable that in some cases these estimates are not very accurate.

The Ottawa River.—The Ottawa River has its source in lakes near the height of land. The river has a length of 700 miles and has a total watershed area of 56,000 square miles. The upper part of the Ottawa flows through a granite plateau of precambrian formation, and the country is low and marshy. Below this granite plateau the river falls rapidly. The upper Ottawa basin contains many lakes having a total area of several hundred square miles. From Pembroke to Ottawa the river is a series of lakes separated by rapids.

Allumette Lake has an area of 60 square miles, Coulonge Lake 25 square miles, Lac des Chats 40 square miles and Lake Deschenes 45 square miles. The river falls rapidly at Ottawa and below this point there is 60 miles of navigable water, reaching to Grenville. From Grenville to Carillon the river falls 50 feet and then enters the Lake of Two Mountains, a large lake having an area of 75 square miles. At the foot of the Lake of Two Mountains the river divides, the major portion flowing to the north of the Island of Montreal, the remainder entering the St. Lawrence River at St. Anne de Bellevue.

Table No. 3.—Water Supplies from Ottawa River.

City or Village	Estimated Population	Estimated Population using water	Average daily consumption (gallons)	Reservoirs Capacity
Pembroke	5,500	4700	600,000	150,000
Arnprior	4,500	700	32,000	85,000
Aylmer	3,100	2600	150,000	60,000
Hull	16,700	16000	3,500,000	
Ottawa	86,100	86100	15,600,000	
Rockland	3,029	2000	50,000	
Hawkesbury	4,300	4000	300,000	
Lachine	10,350	10150	2,500,000	
Westmount	15,000	15000	1,500,000	7,000,000
Verdun	12,500	12250	425,000	
Montreal	455,800	450000	39,000,000	37,000,000

Many tributaries enter the Ottawa River, a list of which is given in Table No. 2 together with their maximum and minimum discharge. The urban population on these tributaries is scant and in only a few cases do municipalities exist which discharge domestic sewage into the rivers.

Population of Watershed.—The total population of the Ottawa River watershed is estimated between 475,000 and 500,000. Within a radius of ten miles at Ottawa, are the municipalities of Aylmer, Hull and Ottawa, having a total population of over 100,000. As only about 20,000 of the remaining population of the main river have sewer outlets into the Ottawa River, it is evident that the great percentage of the urban pollution occurs at Ottawa and vicinity.

From the flow data, secured in the Georgian Bay Ship Canal Survey Report for the Ottawa River, at Ottawa, a maximum flow of 76,000 cubic feet per second is recorded for May, 1910. When compared with the combined population for Ottawa and vicinity, the flow of the stream is about 760 cubic feet per second for each 1,000 of population. When the same comparison is made for the minimum discharge it is noted that the stream flow is 150 cubic feet per second for each 1,000 of population or one-fifth of the maximum flow. Other conditions being nearly the same it is expected that the pollution below Ottawa would reach its maximum during low water stages, when the sewage would receive less dilution than at other times in the year

Industrial Development.—The principal industries on the Ottawa River basin are lumbering and agriculture. At several points on the Ottawa River lumber mills exist which formerly disposed of their sawdust waste into the river. The chief manufacturing plants are for the manufacture of pulp, paper, sulphite and matches. The combined waste from these several plants is very small when compared to the volume of flow in the river.

Domestic Water Supply.—In Table No. 3 is listed information in repard to the water supplies of eleven municipalities on the Ottawa River which receive their domestic water supply from the Ottawa River.

In four of the municipalities, namely, Pembroke, Ottawa, Westmount and Montreal, the river water is purified by means of Calcium hypochlorite. At Verdun the water is filtered by means of a mechanical pressure filter.

It is of interest to note that in several cases the municipalities which have the most polluted water supplies and the highest typhoid death rate have done nothing as yet to improve the quality of their water supplies.

Domestic Sewage.—In Table No. 4 is shown summarized data in regard to the sewerage conditions for ten municipalities on the Ottawa River. This data shows distances below Pembroke, estimated population, estimated population connected to municipal sewers, miles of sewers, and number of sewer outlets into the Ottawa River and other local streams.

It is to be noted that the sewage from a population of nearly 500,000, which is included in this table, does not discharge into the Ottawa River, but into the St. Lawrence River, a portion of which is made up of Ottawa River water.

Manufacturing Waste.—The principal manufacturing waste on the Ottawa River is the bark from the logs. The bark becomes loosened from the log from lying in the water and falls off. A portion of the high color content of the Ottawa River water is no doubt due to the tannin extracted from water soaked bark.

At Ottawa and Hawkesbury the wash water from the pulp and paper mills enter the river. Save-alls are located on these discharge lines and prevent a large percentage of the pulp from gaining access to the river. The total amount of this waste is probably not more than fifteen to twenty million gallons daily. The sulphite liquors from the sulphite mill at Ottawa also discharge into the river. At present the amount of manufacturing waste discharged into the Ottawa River is comparatively small and does not appreciably affect the river, nor does it cause any local nuisances.

Table No. 4.—Sewerage Table for Municipalities on Ottawa River.

City or Village	Miles below Pembroke	Estimated population	Estimated population connected to sewers	Miles of Sewers: Sanitary or combined	Miles of Sewers: Storm	Number of sewer outlets Ottawa in River: Sanitary or combined	Number of sewer outlets Ottawa in River: Storm	No outlets in local streams: Sanitary or combined	No outlets in local streams: Storm
Pembroke	0	5,500	2,500	9.12	4.2	4	5	1	5
Arnpriot	69	4,500	150	4.				2	
Aylmer	97	3,100	800	4.5		1			
Hull	106	12,700	2,600	5.		6	1	1	
Ottawa	106	86,100	83,000	104.3	.75	6		4	
Hawkesbury	166	4,300	4,000	4.		2			
Lachine[a]	219	10,350	10,150	14.2				1a	
Wertmounnt [b]	224	15,000	15,000					b	
Verdun	224	12,500	11,000	8.				1	
Montreal.	223	4 5,800		315				13	

[a] Lachine sewage is discharged in the River St. Pierre which later discharges into St. Lawrence River below Verdun.

[b] Westmount sewage is discharged into Montreal sewers.

Formerly when sawdust was discharged into the river considerable trouble was caused by the formation of huge banks of sawdust.

The river a few miles below Ottawa contains large deposits of sawdust, and large amounts of gas are frequently seen bubbling to the surface. The sawdust undoubtedly undergoes a slow decomposition accompanied by the formation of gas.

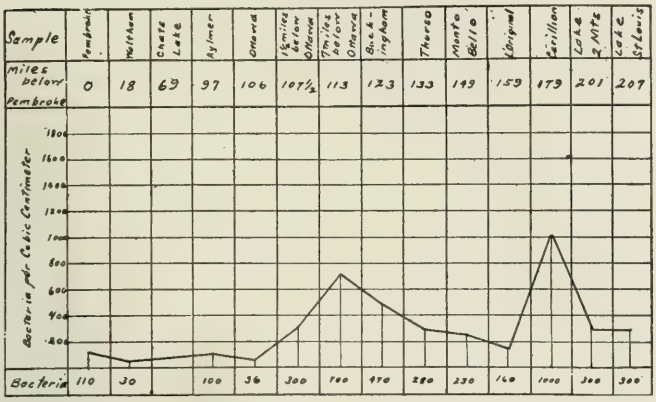
The Dominion amendment of 1895 prohibiting the disposal of sawdust in the rivers came into effect in 1899 and since that time no more of this waste has been disposed of in the Ottawa River.

Character of Ottawa River Water.—For this report, information in regard to the amount of pollution which enters

the river and the effect such pollution has on the public water supplies, has been taken from previous reports and from the analytical data recently collected by this board.

The previous reports consulted are "A Biological Analysis of the Montreal Water Supply during the periods from November, 1890, to November, 1891, by Wyatt Johnston, M.D., appearing in the Montreal Medical Journal of 1894, and "The Bacteriological Analyses of Ottawa River water," by Harrison and Vanderleck.

Figure No. 1.—Showing Bacterial Content of Ottawa River for June, 1910.



Analytical data has also been secured in connection with the Pembroke, Verdun and Montreal water supplies, particularly in connection with the water purification plants.

The work of Dr. Johnston, done in 1891, on the Ottawa River from Ottawa to Montreal, is of great value for comparing the condition of the river at that time with present conditions.

The Ottawa River from Pembroke to Ottawa receives the domestic sewage from a combined population of not over 15,000.

The municipalities discharging sewage into the river between these two points are well separated, and the nature of the river makes purification by natural agencies nearly ideal.

The germ content of the river above Ottawa is comparatively low, except where polluted for a short distance by local sewers.

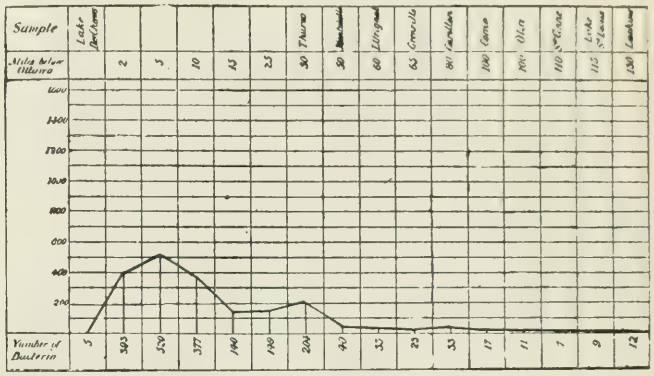
Figure No. 2.—Showing Bacterial Content of Ottawa River for October, 1910.

In most cases B. Coli is absent in one cubic centimeter which shows a rather high degree of bacterial purity for a river water.

Severe typhoid epidemics have occurred at Pembroke, Hull and Ottawa due to infection of the municipal water supplies, but this infection has always been of a local nature, that is, the municipality has infected its own water supply.

Below Ottawa the germ content of the river increases perceptibly, due to the large amount of sewage that enters the river at Ottawa and vicinity. This increase is present all the way to the Lake of Two Mountains, and is much higher during low water than when the river is near its maximum discharge, showing that the amount of dilution is the factor most affecting the germ content of the river from Ottawa to the Lake of Two Mountains.

Figure No. 3.—Showing Bacterial Content of Ottawa River for July, 1891.
(Dr. Wyatt Johnston.)

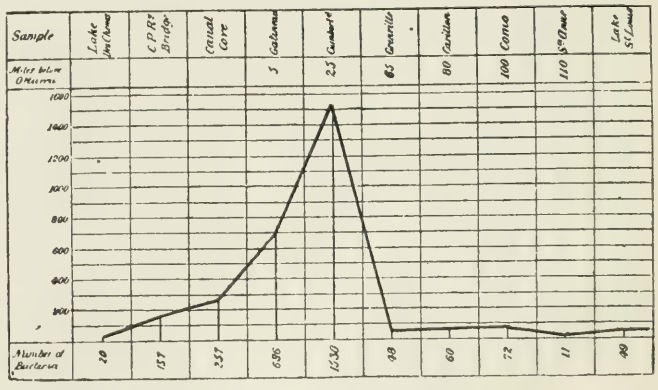


The Lake of Two Mountains acts as a natural settling basin and a decided decrease in germ content is noted after the river water has passed through this lake.

Comparative data of considerable interest is afforded in comparing the results collected by Dr. Johnston in 1891 with those collected by the Provincial Board of Health in 1910.

Dr. Johnston used alkaline gelatine plates incubated at 20° C. The period of incubation is not mentioned in his paper, but was probably not more than 48 to 72 hours, because after that period liquifying bacteria would have destroyed his plates. It will be noted that the results secured by Dr. Johnston are lower than those secured by the Provincial Board of Health. In 1891 Ottawa had a population of 37,300 and Hull 11,300, which is less than half the population of these two cities at present. The results of Dr. Johnston's work on the Ottawa River are shown in Figs. Nos. 3 and 4.

Figure No. 4.—Showing Bacterial Content of Ottawa River for September, 1891.
(Dr. Wyatt Johnston.)

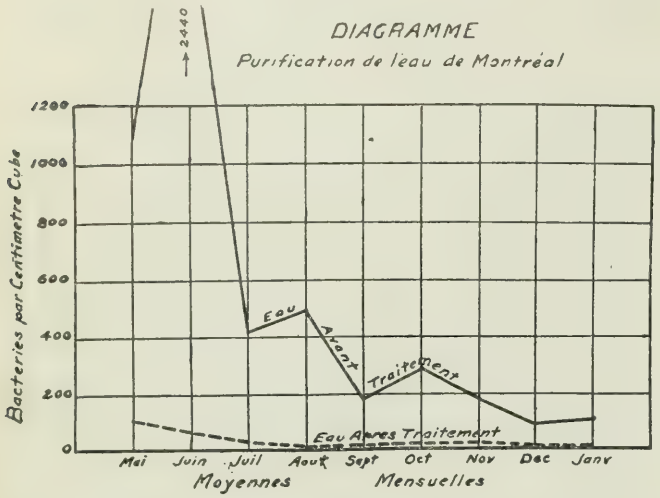


The increased germ content of the Ottawa River below Ottawa is no doubt due to the increased population at Ottawa and vicinity and to the fact that several municipalities below Ottawa now discharge domestic sewage into the river.

On the two trips made by officers of the Provincial Board of Health an increased germ content was noted below Carillon. This increase is probably due to pollution which comes from the lock chambers, as no other source can be found to account for the increase.

The analytical results secured by the Provincial Board of Health are shown in Figs. Nos. 1 and 2.

Fig. No. 5.



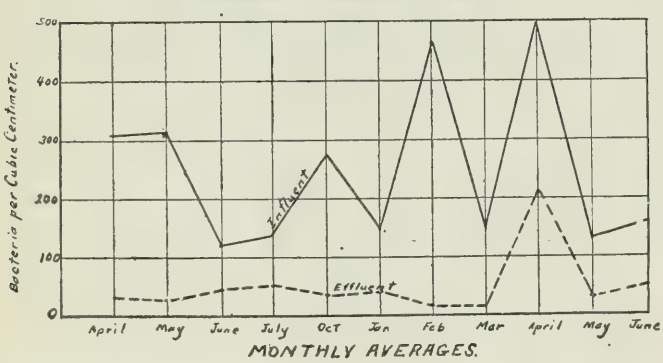
Purification of Ottawa River Water.—The Ottawa River water is being purified at Pembroke, Ottawa and Montreal by means of Calcium hypochlorite, and at Verdun by filtration through mechanical pressure filters.

The disinfection plants are only temporary in character and have been installed to treat the water only until more permanent works are constructed.

The disinfection of the Montreal supply has tended to materially reduce the typhoid fever rate and the results at the other two municipalities have been equally satisfactory.

The city of Montreal is at present constructing a water filtration plant, of the double filtration type, the city of

Figure No. 6.—Bacterial Results Secured at Verdun by Mechanical Pressure Filters.



Ottawa has had its waterworks situation investigated by Mr. Allen Hazen, who has reported on a supply either from McGregor Lake or a filtered water supply from the Ottawa River, and Pembroke has extended its water intake 7,000 feet to take water from mid-stream, thus escaping the eddies which were held responsible for the severe epidemic of 1909.

Fig. No. 5 shows the results secured at Montreal by Calcium hypochlorite sterilization, and Fig. No. 6 shows the results secured at Verdun by filtration.

Typhoid Fever Statistics.—Tables Nos. 5 and 6 shows the typhoid fever mortality at Montreal and Ottawa from 1905 to 1910 inclusive.

The Ottawa statistics appear larger than they should because non-residents who die from the disease in Ottawa are included in the mortality statistics.

Table No. 5.—Deaths from Typhoid Fever at Montreal 1905-1910.

Months	1905	1906	1907	1908	1909	1910
January	8	18	19	12	43	78
February	6	14	6	12	9	29
March	3	13	7	6	12	6
April	2	4	10	7	7	4
May	0	5	11	8	6	9
June	1	4	5	.....	7	5
July	6	4	7	5	7	8
August	7	11	12	5	9	14
September	4	5	12	14	14	13
October	8	18	12	16	24	8
November	4	15	12	22	22	11
December	6	18	9	19	52	7
Total	55	130	122	126	212	192
Death rate per 100,000	14 6	37.	33.2	33.	53.6	42.
Estimated population	303,600	350,500	366,915	380,000	395,000	455,86

Table No. 7 shows the total death rate together with the typhoid death rate for eleven municipalities on the Ottawa River for the year 1910.

Conclusions.—This study has shown that the Ottawa River above the city of Ottawa is in a very satisfactory condition as regards bacterial purity, except where polluted for a short distance by municipal sewers. It is not probable that the amount of pollution for this district will increase perceptibly for a considerable period of time.

Table No. 6.—Deaths from Typhoid Fever at Ottawa, 1905-1910.

Months	1905	1906	1907	1908	1909	1910
January	1	1	7	0	2	2
February	2	0	4	0	11	3
March	1	2	3	0	1	2
April	0	1	3	1	1	1
May	2	1	2	0	0	0
June	1	0	1	1	1	1
July	1	0	0	2	1	1
August	1	0	2	1	0	2
September	1	2	3	1	5	3
October	0	4	4	7	2	7
November	2	0	4	2	9	1
December	1	2	3	6	2	2
Total	13	13	36	21	25	25
Estimated population	65,500	67,572	69,715	80,284	83,360	86,186
Death rate per 100,000	20.	19.2	51.6	26 1	30.	29

The work done has shown that the sewage of Ottawa and Hull pollutes the Ottawa River for a considerable distance below these municipalities. The Ottawa River from Ottawa to St. Anne de Bellevue is not fit to use in its raw state as a domestic water supply.

Table No. 7.

City or village	Miles below Pembroke	Population	Deaths in 1910		Deaths per 100.000	
			Total	Typhoid	Total	Typhoid
Pembroke	0	6000	90	2	1500	33.3
Arnprior	74	4300	53	1	1229	22.7
Aylmer	103	3000	56	1	1860	33.
Hull	110	16500	348	3	2110	18.2
Ottawa	110	86200	1465	25	1700	29.
Rockland	135	3000	74	3	2470	100
Hawkesbury	175	4300	79	5	1837	116
Lachine	228	10000	167	1	1670	10
Verdun	234	10000	177	0	1770	0
Westmount	235	15000	93	3	620	20
Montreal	235	455800	10211	192	2240	42

Because of the high color content of the Ottawa River water, mechanical filtration will be found to be the most satisfactory method to be adopted to secure a purified water of satisfactory physical appearance and bacterial purity.

A portion at least of the pollution which enters the river at Ottawa and Hull should be removed so as to lighten the load on the smaller municipalities located below on the river, which will soon be forced to consider the purification of their municipal water supplies.

The amount of manufacturing waste which now enters the river causes no appreciable nuisance, and it is not at all probable that this waste will so increase as to be a polluting factor.

The construction of the proposed Georgian Bay Ship Canal will have a considerable effect on the Ottawa River. In some cases additional pollution will enter the river, but the probable biggest factor will be the equalizing of the flow of the river, which will tend to prevent the maximum pollution which occurs during the low stages of the river.

The Ottawa River, being an interprovincial stream, is outside of the jurisdiction of either province.

This condition suggests federal authority and sanitary control over such streams and bodies of water as do not lie entirely within the confines of one province.

WAVE IMPACT ON ENGINEERING STRUCTURES.

It is a well-known fact that the impact of a wave on the face or top of a breakwater formed of blocks of masonry or concrete may cause such a block to start from its seat in the opposite direction to that of impact, and may actually cause its withdrawal from the face or top of the breakwater. Cases in which blocks weighing several tons and carrying the weight of several superposed courses have been withdrawn in this manner are of comparatively frequent occurrence. The explanations of this phenomenon which have been current in the past attribute it either to the fact that the wave pressure on the face of the breakwater at the instant of impact is transmitted hydrostatically, as in an hydraulic press, to every portion of the interior, thus giving rise to an excess outward pressure at those portions of the face over which the wave is not the instant breaking, or to the compression of the air which is entrapped in the open joints. Such a compression gives rise to an internal pressure, which is maintained for some small but finite interval of time after the recession of the wave has relieved the pressure on the face. An experimental investigation recently carried out by members of the Engineering Department of University College, Dundee, and published in the Proceedings of the Institution of Civil Engineers, indicates that, assuming a maximum velocity of wave impact of 80-ft. per second, the maximum internal pressure to be anticipated on the first of these assumptions is about 2.9 tons per sq. ft., while, assuming air compression, the pressure may amount to about six tons per sq. ft. The experiments, however, point to the fact that in favorable circumstances the impact of the wave on an open joint gives rise to a "water hammer" action, analogous to that following the sudden closure of a valve at the open end of a long pipe line conveying water. Where this action occurs, pressures vastly in excess of those possible either by simple hydrostatic transmission of pressure or by air compression, are produced, and, with the assumed velocity of impact, they may amount to some 40 tons per sq. ft., or even more in specially favorable cases. The results suggest the advisability of providing a free outlet, by means of a series of drains or weed-holes opening on its sheltered face, for such water as may percolate to the interior of such a structure. Such drains, preventing the accumulation of internal water, would be an effective guard against the production of internal pressures of sufficient magnitude to affect the stability of the structure, whether due to air compression or to water hammer.

THE PREVENTION OF SMOKE.

The sight of black, thick smoke emerging from the smoke stacks of industrial plants at once inspires a feeling of prosperity and plenty. Seen from some distance this does not cause inconvenience, but at closer range it becomes obvious that it is not only inconvenient but disagreeable in the extreme, so much so, in fact, that legislation has been brought about in many municipalities to reduce what is commonly called "the smoke nuisance."

It took considerable time to educate large fuel consumers to the fact that the greater portion of the smoke going out to polute the atmosphere was really waste heat, and could be employed to great advantage in their own boilers, but within the last few years there has been a remarkable development in the utilization of coal under the steam boiler, and to-day many steam plants are burning bituminous coals practically without smoke. This is largely due to improvements in the design of the furnaces and more care on the part of the firemen.

Within the last few years there has been a remarkable development in the utilization of coal under the steam boiler. To-day many steam power plants in the United States are burning bituminous coal practically without smoke. This has been brought about by improving the design of the furnaces and by careful attention on the part of the firemen.

It is now possible to design and operate boiler plants burning a high-volatile coal which will be practically smokeless under usual operating conditions, giving off no black or dense gray smoke except when a fresh fire is being built. Banking the fire, shutting dampers, etc., cause smoke of a light or gray shade only. This has been demonstrated at the engineering experiment station of the University of Illinois, where a boiler has been installed, properly equipped with a furnace for burning Illinois coal. Under ordinary conditions this plant makes no smoke whatever. This equipment is not suitable for burning low-volatile coals such as are largely used in the East. In experimenting with this furnace an effort was made to produce smoke, but it was found impossible to make black smoke, the worst being about 50 per cent. black.

Coal can be burned smokelessly, the same as gas, gasoline, or kerosene oil, if the equipment is properly designed and adjusted. Each of these fuels will give off smoke if conditions are not favorable. All the authorities on the subject of combustion and smoke prevention agree upon the following conditions as requirements for a smokeless furnace:—

1. The coal should be supplied to the furnace in small quantities at frequent intervals. The more nearly the feed approaches a continuous and uniform supply the better the results.

2. The air supply should be slightly in excess of the theoretical amount required and be admitted principally through the fuel bed, with an auxiliary supply admitted at the front or rear of the furnace to burn gases from the coal.

3. The temperature in the furnace should be sufficiently high to ignite the gases given off from the fuel bed.

4. There should be a fire-brick combustion chamber of sufficient dimensions and so designed as to cause the thorough mixture of the gases and air, permitting complete combustion before the mixture reaches the boiler surfaces.

It has been found in this country, as well as in Europe, that when smoke is given off there is also a loss of carbon monoxide (CO) and other combustible gases. The loss due to the carbon which we see and call smoke is seldom more than 1 per cent., but the loss due to the escape of the combustible gases may amount to an additional 3 to 10 per cent.

It has been found that, contrary to general opinion, with extremely high temperatures more smoke is produced

and more unburned gases are lost up the stack. High temperature is of course due to a supply of air approaching the theoretical amount, and on account of the difficulty of obtaining a complete mixture of the gases and air some gas is allowed to escape unburned. (See Table 1.)

The combustible gas most frequently found in the flue gases is carbon monoxide (CO). This gas is nearly always present when the stack gives off black smoke, indicating imperfect combustion. Hydrogen and hydrocarbon gases may also be expected in connection with the CO, but on account of the difficulty of determining the small percentages of these gases they are seldom recorded, though the loss due to their escape is considerable. In confirmation of these statements, the accompanying tables are submitted. Table 1 gives a summary of the relation of smoke to unburned gases and combustion-chamber temperatures as determined from more than 200 boiler tests made at the St. Louis, U.S.A., fuel-testing plant.

Table 1.—Relation of Smoke to CO and Combustion-Chamber Temperatures.

	Per Cent. of Black Smoke.						
	0	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60
Number of tests	37	18	56	51	36	17	4
Average per cent. of smoke	0	7.1	15.5	24.7	34.7	43.1	52.9
Average per cent. of CO in flue gases	0.05	0.11	0.11	0.14	0.21	0.33	0.35
Average per cent. unaccounted for in heat balance	9.14	10.60	9.46	10.93	11.41	13.41	13.34
Number of tests [a]	26	16	48	45	32	17	4
Average combustion-chamber temperature (°F)	2,180	2,215	2,357	2,415	2,450	2,465	2,617

[a] Temperatures in combustion-chamber were not determined on all tests.

Table 2, from the Manchester report, gives analyses of chimney gases, including determinations of hydrogen (H_2) and methane (CH_4), which occur in small percentages.

Table 2.—Analyses of Chimney Cases.

	Smoky.						Clear.					
Boilers.	CO_2.	O_2.	CO.	CH_4.	H_2.	N_2.	CO_2.	O_2.	CO.	CH_4.	H_2.	N_2.
No. 1, hand-fired	11.00	6.90	0.90	....	....	81.20	....	....	....	....	....	....
	10.65	6.45	2.15	....	....	80.75	....	....	....	....	....	....
No. 1, with smoke-prevention device	....	....					7.00	13.50	0	....	....	79.50
							9.00	9.75	0	....	....	81.25
No. 2, hand-fired	10.25	8.60	.50	0	0	80.65	....	....	....	....	....	....
No. 3, hand-fired	13.25	3.50	.05	0.25	0	82.95	....	....	....	....	....	....
No. 4, fire under caustic pot, hand-fired	10.95	1.30	3.00	.70	3.23	80.82	....	....	....	....	....	....
No. 5, split bridge, hand-fired	8.75	7.00	3.25	.40	1.00	79.60	....	....	....	....	....	....
No. 6, with smoke-prevention device	....	....	....	....	....	....	7.25	12.00	0	0	0	80.75
No. 7, with smoke-prevention device	....	....	....	....	....	....	7.15	12.15	0	0	0	80.70
No. 8, with smoke-prevention device	....	....	....	....	....	....	8.15	11.10	0	0	0	80.75

Table 3, compiled from results obtained at the above-mentioned fuel-testing plant, shows that the losses due to the escape of CO and other combustible gases may be considerable and that they are of more importance than the gain from a corresponding increase in carbon dioxide (CO_2). It is evident that the prevention of smoke and the efficiency of the plant are very closely related.

Table 3.—Relation of CO to Efficiency.

Number of tests.	15	11	29	25	21	28	42	32	34	49	7
Average per cent. of CO_2 in flue gases	7.69	9.46	9.29	9.09	9.48	9.48	9.90	9.60	9.57	10.22	10.94
Average per cent. of CO. in flue gases	.63	.53	.27	.22	.17	.19	.13	.16	.12	.15	.10
Average efficiency (72*) [a]	52.96	56.73	59.56	62.08	63.43	64.58	65.55	66.41	67.48	69.10	71.73

[a] For discussion of efficiency 72*, see A study of four hundred steaming tests: U.S. Geol. Survey. Bulletin No. 325, 1907.

LARGE CONTRACTS LET BY THE C. P. R. DEPARTMENT OF NATURAL RESOURCES.

A. S. Dawson, Chief Engineer of the C.P.R. Department of Natural Resources, reports the awarding of three large and important contracts in connection with the construction work in the Eastern Section of that company's Irrigation Block.

Messrs. Grant, Smith and Co., and McDonnell, of Vancouver, have been awarded a contract running into over $500,000 for the construction of a large reinforced concrete aqueduct, two miles in length, near Brooks, which will take the next two summers to complete.

Messrs. Jansey Bros., and Boomer and Hughes, of Calgary and Seattle, have been awarded a two-year contract, amounting to about $300,000 for the construction of a very large number of reinforced concrete structures on the canal system in that section of the Irrigation Block lying between Bassano and Brooks and the Bow and Red Deer Rivers.

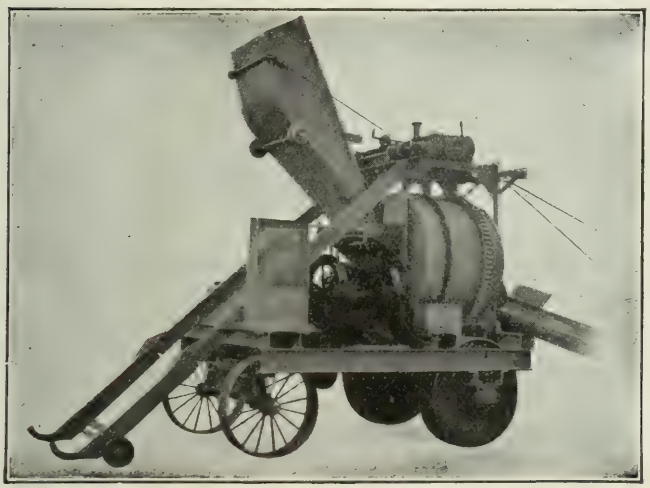
The Canada Foundry Company have also been awarded a large contract for the supplying and erection of 30 steel bridges over the main canal system, containing about a million and a half pounds of steel, which, with masonry abutments, will provide practically permanent structures.

Work on all of these contracts will be commenced in the immediate future, and several hundred men, large numbers of teams, and an elaborate construction plant will be required for their completion.

A NEW DESIGN OF STREET MIXER.

The Ransome Concrete Machinery Co., Dunellen, N.J., have just put on the market two new types of street mixers, the No. 60 and No. 61. There are many points about these which are different from anything which has been offered to date by mixer manufacturers, and the design has been made by the Ransome Company after a long study of the street paving contractor's problems. The No. 60 machine is a steam driven outfit regularly furnished with 10-foot distributing chute capable of handling 14 cubic feet of loose material, and will mix 40 to 60 batches per hour depending upon the speed which the material can be fed to the pivot hopper. The engine is 8 h.p. and the boiler 9 h.p. The machine is arranged to drive in both directions along the work.

The various levers controlling the operations of hoisting, discharging and traction are all brought to one point and the entire operation can be controlled by the engineer. The chute will swing through an arc of approximately 180° while the discharge point is 3ft. 7in. above street level. The outfit is mounted on 24 and 28-in. wheels with 10-in. tires. The net weight of the machine complete with power is approximately 11,000 lbs.



View of the No. 61 Mixer Showing Skip Discharging and Chute.

The No. 61 Ransome street mixer will handle up to 20 cubic feet of loose material and will mix from 40 to 60 batches per hour. It is regularly equipped with a 2-cylinder opposed gasoline engine and 2 20-ft. distributing chute. It is arranged with a clutch by which the drum can be thrown out and remain idle while the machine is traveling along the road, and it is also equipped with a traction device adapted for moving in either direction. A notable feature of this outfit is the fact that the over-all height has been kept within 11 ft. 2 ins. This has been done by eliminating the charging hopper and emptying direct from skip into mixer.

The driving wheels are 44-ins. in diameter and the front wheels 40-ins., the tires being 10-ins and 8-ins. respectively. By using these large wheels an 18-inch clearance above the ground has been made possible, thus avoiding any jacking up of the machine to clear manholes which are liable to project 12-ins. or more above the sub-grade of an unfinished street. When desired, flanges may be bolted to the tires, thus making the outfit suitable for operation under the machine's own power on trolley tracks, etc. If the outfit is to be drawn behind a trolley car at high speed, standard flanged wheels may be readily substituted for the ones regularly furnished, as the wheels are easily taken off inasmuch as the driving axle is mounted in split boxes and the front axle can be swung around and the wheels slipped off.

All of the operating levers have been brought adjacent to the operating platform at one side of the machine. The steering wheel is in front. The line shaft is driven by chain and the power is transmitted through clutches to the windlass for operating the hoist, the drum and the traction wheels. Of course, when desired an electric motor can be substituted for the gasoline engine, and when operated in railway service the motor could be run from overhead trolley wire. The general dimensions are as follows:

Weight	15,000 lbs.
H.P.	16
Height over-all, skip raised	14 ft.
" " exclusive of skip	11 ft. 2 ins.
Extreme width	8 ft. 6½ ins.
Length, exclusive of skip and chute	17 ft. 1 in.
Length, with skip lowered	20 ft. 10 ins.

HEAVY ELECTRIC TRACTION IN EUROPE.

At a meeting of the American Institute of Electrical Engineers held at Schenectady, N.Y., May 17, 1912, C. E. Eveleth, General Electric Company, presented a paper entitled "Some Impressions of the Electric Traction Situation in Europe." Perhaps the most fundamental difference from American practice was in the relative magnitude of the drawbar pulls required for handling either freight or passenger trains. The ordinary European drawbars were designed for normal working pulls of 12 tons to 15 tons and or a breaking strength of approximately twice these values. Some American drawbars had shown normal working values of 40 tons to 50 tons and breaking strengths of 100 tons to 150 tons. In Europe there were practically no automatic couplers, as the cars were generally coupled by links with turnbuckles. The train limitations were such that with a liberally powered locomotive not more than 60 tons could be utilized on the drivers, whereas Americans do not hesitate to couple two locomotives to secure a total weight of about 200 tons on the driving axles at the head end of the train, as in the Detroit River and the Great Northern electrifications. European locomotives with plate-frame structures were made to withstand end strains of about 30 tons. In this country the locomotives were designed for end strains of approximately two and a half times the locomotive weight. These differences naturally lead to radically different types of mechanical design. The lower tractive effort at starting demanded of European locomotives resulted in equally radical differences in the electrical design of the motors.

England.—Mr. Eveleth said that studies were being made for the electrification of the steam suburban traffic in several large cities like London, Manchester and Liverpool. Suburban electrification had been very much affected by the introduction of motor buses and the extension of surface tramways. The London, Brighton & South Coast Railway's loop from London Bridge to Victoria Station offered an interesting example of the benefits of electrification. About seven or eight years ago, when this division was operated by steam, about 8,000,000 tickets a year were sold. Owing to the development of surface transportation competition, these sales dropped to about 3,500,000 tickets per annum. However, since the single-phase electrification was completed about two years ago, the ticket sales have increased so rapidly that they are now about 9,000,000 per annum.

Mr. Eveleth thought that the general consensus of engineering public opinion in England seemed to indicate a decided preference for direct current for the English conditions. The London, Brighton & South Coast line, of course, was an exception. No operating costs on the Brighton system had been made public, and the manufacturer appeared to be still interested in the experimental development of the motors and control, so that all maintenance was not yet entirely in the hands of the railway. Several of the electrifications under consideration were being studied on the basis of 1,200 volts direct current and higher. One manufacturer had already built a 3,500-volt d.c. locomotive, energy for which was furnished by a single-commutator 3,500-volt machine.

Holland.—The great extent of the freight transportation by canal in Holland made it hardly likely that any considerable electrification of steam railroads would soon take place there. The single-phase electrification between Rotterdam, Haag and Scheveningen had been taken over by the parallel steam railroad. The schedules on this line were not severe, and the service called for an average of about one stop in 10 miles. The maintenance costs were said to be rather high and no immediate extensions were contemplated.

France.—Considerable study was going on in France, but as yet there had been no large installations. The engineers of the Paris-Mediterranean-Lyons Railway had developed a locomotive which took power from a single-phase trolley and operated d.c. motors on the axles, the current for these motors being transformed by a synchronous commutator known as a permutator. In its present state this locomotive was purely experimental. The single-phase system was represented by one or two small tramway lines and by some undertakings which were being carried out by the Midi Railway. The latter company had purchased five different single-phase locomotives from as many manufacturers for experimental operation in Southern France on sections involving heavy grade haulage with regenerative braking. Up to March, 1912, three locomotives had been delivered. The electrifications were being carried out under government subsidies, without which they would hardly be justified, as there was little traffic. Several of the lines to be operated electrically had not yet been built, and it would probably be several years before the locomotives were in active operation. The 2400-volt, three-wire d.c. system at Mure was now being extended with a trolley having 2,400 volts between the overhead conductor and the track. The most serious undertakings contemplated in France were those connected with the electrification of the steam railroads at Paris, although the State Railways and the Paris-Orleans Railway contemplated the extension of their electric suburban lines with the d.c. third rail. Mr. Eveleth found that the engineers of the French State Railways believed that the direct current was cheapest in first cost and operation for any of their lines upon which electrification was desired.

Switzerland.—The Simplon tunnel three-phase electrification appeared to be successful in every way. At first great trouble was experienced from insulation breakdowns on both motors and transformers due to condensation when the cool locomotive passed into the tunnel where the temperature is about 115 deg. Fahr because of hot springs. This condensation caused every portion of the electric locomotive to be drenched with water. This trouble is now avoided by warming the locomotives over heated pits at the terminal before they enter the tunnel.

In making studies for the electrification of the St. Gotthard tunnel the engineers of the Swiss government found that the single-phase system was about 20 per cent. less in first cost than the three-phase system and about 33 per cent. less than direct current. This difference between the installation cost of direct current and single-phase was much greater than had ever been found in any analysis of conditions in the United States. Some of the fundamental assumptions of the Swiss analysis were as follows: Cost of single-phase d.c. locomotives essentially the same; each substation equipped with motor-generator sets and complete installation of spare units; each substation equipped with storage batteries; substations located half the calculated required distance apart to insure continuity of service in case of disaster to any individual station. Voltage regulation conditions were taken to be considerably better than those generally adopted in America. It was estimated that the direct-current and single-phase locomotives would have essentially the same maintenance costs, and that these costs would be about one-half of those required for steam locomotive upkeep.

Italy.—The most important electrifications in Italy were the three-phase installations by the government at Valtellina, Mount Cenis and the Giovi tunnel near Genoa. Electric traction applications in Italy had been made on mountain grades and those contemplated in the immediate future involved similar conditions. The work had proved entirely satisfactory to the government both as regards installation and operating costs. The extensions now contemplated would involve the purchase of several hundred locomotives within the next two years. The electric locomotives on the Genoa division would soon haul about 15,000 freight cars a day, thus making it the heaviest section of electric traction on the Continent. A most extraordinary and perhaps unexpected saving had been found in the reduction of rail wear. When the Giovi tunnel was operated entirely by steam the up-grade rail lasted about twelve years and the down-grade rails about three and one-half years. Apparently the restricted axle movement with brakes on the descending steam train resulted in a scouring action on the railheads. At any time during steam operation fresh deposits of metallic dust from the rails and brakeshoes were to be seen on the ballast. Electric service for one and a half years indicated that the down-grade rail would last as long as those on the up-grade tracks. This saving of practically two sets of rails in twelve years was equivalent to approximately the total interest on the power plant and transmission system. Allowance was now being made by the Italian engineers for this factor in making electrification studies for tunnel conditions similar to those at Genoa. Mr. Eveleth thought that this character of saving had not been recognized in America, probably due to the fact that practically all American tunnels with grades are single track, and the difference of wear between the ascending and descending track with the steam service had not been recognized.

Regeneration had also affected a saving of 17 per cent. in coal. When the entire division was electrified the possible saving in coal would be much higher. The difference in the energy represented by the present saving and the anticipated saving was now wasted in the water rheostats at the power house, which were adjusted to dissipate energy in excess of that which could be utilized by ascending trains. The Italian engineers were enthusiastic over the three-phase system for their conditions, and the results obtained certainly warranted their enthusiasm.

Germany.—The most important developments in Germany were in connection with the state railroads. The government engineers believed in the economic advantage of electrification which permitted the use of inferior grades of brown coal which were not fit for ordinary locomotive service.

Up to the present time all of their work had been of an experimental character, but this had been combined with the commercial operation of the Hamburg-Blankenese-Ohlsdorf line, on which multiple-unit motor-car trains were used.

Referring to the Dessau-Bitterfeld locomotives, Mr. Eveleth found it interesting that the tendency in Germany was to make a single motor do as much as possible by coupling it to several driving wheels, while in the United States the tendency was to have a multiplicity of small, higher-speed motors connected in some way to the wheels through gearing. About six years ago the German government engineers had decided upon the standardization of single-phase in the belief that it was best adapted to German conditions, which required uniformity, chiefly for military reasons. The relative amounts of operating expenses compared with other systems had apparently not been investigated. All of the principal German manufacturers were now taking very active interest in the development of d.c. equipment for 1,000 volts and more. There were a dozen or more gas-electric cars in passenger service on the Russian frontier and it was understood that about 100 more were soon to be built.

Sweden.—The experimental lines built in Sweden some years ago had been dismantled, but the government had recently contracted for the equipment of one of its Lapland lines to transport iron ore from Kiruna to Riksgränsen. The Swedish engineers were also engaged in the development of gasoline-electric and Diesel electric car equipments for general use throughout the kingdom.

ON THE IMPOUNDING OF WATERS TO PREVENT FLOODS.

By A. H. Purdue.

The recent disastrous floods of the Mississippi have impressed anew upon the mind of the public the necessity of adopting all possible measures to prevent the recurrence of such in the future, and if this can not be done, to reduce the effects to the minimum. The subject was discussed at the Southern Commercial Congress, which met in Nashville from the 8th to the 10th of last April, and was a natural theme at the National Drainage Congress, which convened in New Orleans from the 10th to the 13th of the same month.

At both of these congresses there were those who advocated from the platform the impounding of the headwaters of the Mississippi as a solution of the flood problem. While this proposed means of controlling floods doubtless has been investigated by competent engineers, the writer is ignorant of their conclusions; but it has always seemed to him that such is impossible, and on account of the great cost, impracticable were it possible. For his own satisfaction, he indulged in a little investigation relating to the distribution of the rainfall that supplies the flood waters of the Mississippi, the results of which are given later in this article.

Any consideration to determine the feasibility of controlling floods must take into consideration what becomes of the rain that falls upon the earth, for this is the source of flood waters, as of all the waters upon the land. A part of the rainfall evaporates, a part soaks into the ground, and a part runs off over the surface.

The amount that evaporates varies with the dryness and the temperature of the atmosphere. In arid regions, this is always great—so great that much of the rainfall disappears before it reaches the ground. In humid regions, it is great in summer, when the air is both dry and warm; and small in winter and spring, when the air is moist and cold. The amount that soaks into the ground varies with a great many things, among which are the rate of the rainfall, the steepness of the slope, the vegetation of the surface, the amount of water in the ground, and whether or not the ground is frozen.

If the rain falls rapidly, a much smaller amount enters the ground than if it falls slowly. In running over steep slopes, much less enters the ground than if the slopes are flat. If the surface contains little or no vegetation, much less water will enter the ground than if it be covered with grass or forests. If the ground is frozen, but little or no water can enter it. If the ground is full of water, no water can enter, and it must all run off. The last named condition probably is more important in considering the causes of floods of large streams than any other, though it is the one most commonly overlooked.

The part that evaporates has nothing to do with floods or with stream flow. The part that enters the ground is the source of supply for springs, seeps, growing crops, forests, etc. This is the only supply of streams in times of drought. The part that runs off is the cause of floods.

Those who favor the impounding of waters to prevent floods reason as follows: The Mississippi gets its chief supply of water from the Ohio and Missouri. The supply of the Ohio comes from the Appalachian Mountains and that of the Missouri from the Rocky Mountains. If the supply of these two streams were dammed up in the numerous deep ravines and valleys through which it flows in their upper courses there could be no flood.

So far as it goes, this is all right. The large run-off in these parts does cause floods in those parts. But it is a mistake to suppose that these waters are the only source, or even the main source, of supply of the flood waters of the Ohio and Mississippi. The Ohio drains West Virginia, most of Tennessee, a part of Illinois, most of Indiana and Ohio, and part of Pennsylvania; and the Missouri River drains a large part of the eight states along its course. Besides, there flow into the Mississippi a large part of the waters of Illinois, Wisconsin and Minnesota. In fact, the headwaters of the Ohio and Missouri, which streams are the chief source of supply for the Mississippi floods, are only a small fraction of the supply of those streams. Most of their waters are received along their courses after they leave their mountainous headwater areas.

The effect of the great area of the central states upon floods is overlooked by those who advocate impounding to prevent floods along the Mississippi, because it is supposed that their generally flat surface causes most of the water to soak into the ground. But it must be remembered that after the ground is frozen or is full of water no more can enter, and what falls must run off. It is during the seasons of general and prolonged rains over the Mississippi Valley that the floods occur. After the ground becomes saturated with water, the rainfall of this great central area must at once find its way through the numerous streams that finally converge into the Mississippi. If the Ohio and the Missouri are in flood separately, the lower Mississippi can carry off the waters without overflowing. The disastrous floods come when these two rivers and the upper Mississippi are discharging large volumes of water at the same time. If it so happens, as is usually the case, that Arkansas and Red Rivers are then in flood the waters from these check the flow of the lower Mississippi and cause the accumulation of water between their mouths and the mouth of the Ohio.

To ascertain where the water comes from that causes the Mississippi floods, the following table has been prepared. The rainfall over the area that supplies the flood waters is

taken for the months of February, March and April, as it is this water that usually produces the floods.*

Table of the Average Precipitation and Volume of Rainfall for the Months of February, March and April Over the Flood Supplying Portion of the Mississippi Basin.

STATE	Months Feb.	Mar.	Apr.	Total	Area	Per cent. drained into Miss. River	Billion cubic yds. drained into Miss R.
Montana	0.78	1.21	1.28	3.27	145,310	90[2]	36.80
Wyoming	0.83	1.49	1.46	3.78	103,645	75[2]	25.27
North Dakota	0.56	1.03	1.58	3.17	70,195	66[2]	12.63
South Dakota	0.48	1.27	2.10	3.85	76,850	100	25.44
Nebraska	0.72	1.11	2.61	4.44	76,840	100	29.34
Kansas	0.99	1.45	2.59	5.03	81,700	100	35.34
Oklahoma	0.74	2.20	2.68	5.80	70,430	100	35.13
Minnesota	0.71	1.40	2.15	4.26	79,205	66[2]	19.15
Wisconsin	1.13	1.98	2.44	5.55	54,450	75[2]	19.49
Iowa	1.06	1.92	2.83	5.85	55,475	100	27.91
Illinois	2.37	3.18	3.30	8.85	56,000	100	42.62
Indiana	2.89	3.85	3.11	9.85	35,910	93[2]	28.29
Missouri	2.29	3.57	3.62	9.48	68,735	100	56.04
Arkansas	3.55	5.22	4.18	12.95	53,045	100	59.08
Pennsylvania	3.02	3.75	3.03	9.80	44.985	25[2]	9.48
Ohio	2.60	3.50	2.87	8.97	40,760	75[2]	23.58
West Virginia	3.06	4.29	3.75	11.10	24,645	100	23.52
Kentucky	3.57	5.24	3.46	12.27	40,000	100	42.21
Tennessee	4.72	5.24	4.24	14.20	41,750	100	50.98
Colorado	1.03	1.02	2.01	4.06	108,645	33[2]	12.52
Total					1,328,575		614.82

It will be seen from the table that the volume of the average rainfall of the area for the three months is 614.82 billion cubic yards. This is equal to 112,774 cubic miles, and would cover the states of Ohio, Indiana and Illinois to the depth of 4,488 feet. This, it must be remembered, is the volume of the average rainfall. In seasons of unusual rainfall, like the past spring, the volume is of course much greater. It must be disposed of by running off, by soaking into the ground, and by evaporation. As the evaporation at this season of the year is small, most of the water must be disposed of by the other two processes; and as the ground is full or nearly full of water, or is frozen, over a large part of the area named, an unusual per cent. of the enormous volume disappears as run-off. It is this that produces the floods. If half of it is run-off, this would cover the three states named to the depth of 2,288 feet, when the rainfall for the three months named is normal. The Mississippi River Commission doubtless know how much water the Mississippi can discharge within a given time without flooding. The difference between this and the volume of the run-off is what would have to be impounded to prevent floods.

No attempt was made to approximate the entire area over which the headwaters of the Mississippi might be impounded, for without surveys such would be little more than a guess; but in order to get at some idea of the possible effectiveness of impounding, it is estimated that the water over 30,000 square miles about the head of the Ohio can in part be put under such control. This is thought to be a very liberal estimate. The area and volume that could be impounded in Wyoming and Montana was not estimated, but it will be noticed by reference to the table that the total rainfall in these states, for the three months named, is small.

The volume of the rainfall over the area taken about the headwaters of the Ohio for the three months named, is approximately 26.96 billion cubic yards, or only 4.37 per cent. of that over the entire area that supplies flood waters to the Mississippi. It will be seen that even though all this disappeared as run-off, and could all be impounded, the effect upon the floods of the Mississippi would be insignificant. But a part of it soaks into the ground, and a part evaporates. The amount that could be impounded would probably be only a small per cent. of the remainder, or the run-off, for with the steep gradient of the streams, the reservoirs would soon fill and overflow. The floods would be reduced only by the small per cent. that they could hold. To accurately determine this, would require careful surveys.

Probably the headwaters of the Ohio and other streams can be so impounded as to avoid disastrous floods in these parts, and at the same time furnish a large amount of needed water power. The contention here made is that it seems impracticable to so impound the water of the Mississippi Basin as to prevent the disastrous floods of that stream. The only known means of controlling this water in times of prolonged and general rains is by levees; and for these to be made reliable, they will have to be strengthened by the use of concrete, or by other means. This would be an enormous and expensive undertaking, but the great Mississippi never can be subjugated without an outlay of many millions.

*The average rainfall for the states and months named was supplied by Mr. Roscoe Nunn, of the U.S. Weather Bureau, Nashville, Tenn.

[1]The computations were made by A. R. Dismukes, Assistant Instructor in Surveying, Vanderbilt University.

[2]Approximated.

RADIUM.

The infrequency of deposits of uranium ores and the ever-growing demand for its product—radium—has enhanced the price of the latter to an almost prohibitive point. Though the most important accumulations of pitchblende are worked at Joachimsthal, in Bohemia, there are many other countries in which radio-active minerals exist. In Cornwall pitchblende occurs in many tin veins with uranite and bismuth; in St. Stephen's are two lodes intersecting clay slates, which have yielded large quantities of pitchblende and uranite; chalcolite, a phosphate of uranium and copper, of an emerald green color, has been met with in beautiful crystals at Gunnis Lake, Tincroft, and other mines. Pitchblende has been found also at Rezbanya, in Hungary, and near Adrianople. Small veins of uranium phosphate occur in Portugal and at Autun. Copper uranite occurs in the mines of Saxony.

The discoveries of carnotite, also a phosphate of uranium, near Olary, 200 miles northwest of Adelaide, on the Broken Hill Railway, have been prominent. From Radium Hill 30 tons have been expedited to European laboratories. The reserves have been estimated at 5,600 tons, which are estimated to produce 5½ millograms of radium bromide per ton and 162,400 lbs. of uranium oxide. Works are being erected to manufacture radium, and the manager expects to have two grammes of bromide within a year, which at present price would represent $150,000. Near Mount Painter, in South Australia, is a vein over a mile in length, from which has been obtained autunite containing 30 per cent. of oxide of uranium, and six tons have been exported to Europe. Radium being so valuable, prospectors should carefully examine all unknown dark yellow or green minerals, which can be easily tested with sensitised collodion paper by placing the specimen on it and leaving it in the dark for a fortnight; the paper, after development, will be found peculiarly mottled with black spots. At the growing village of Joachimsthal a kurhaus was established in 1910, where radio-active baths are enjoyed and radio-active water drunk medicinally.

WORK OF THE COMMISSION OF CONSERVATION.

Public health, agriculture, forestry, fisheries, minerals and water-powers, in various important aspects, are dealt with in the third annual report of the Conservation Commission. Probably the most immediately interesting subjects discussed are the consolidation of the various public health services of the Dominion and the measures for the protection of forests from fire that have recently become law.

The public health section of the report states that the Dominion spends yearly the sum of $377,485 on various public health services scattered among four different departments, and shows how economy could be effected and efficiency gained by consolidating these under one public health branch. Other public health topics discussed are meat inspection, uniform vital statistics, biological laboratories for preparing vaccines and anti-toxins, and housing and town planning.

As a result of the agitation carried on by the commission ever since its inception, a law was passed last year by which railways are held responsible for damages inflicted by forest fires caused by their locomotives and are required to patrol dangerous portions of their lines during the dry season. A few weeks ago the railway commission promulgated regulations under this law. Mr. Clyde Leavitt, forester of the commission of conservation and chief fire inspector for the railway commission, is now in British Columbia to see that the regulations are carried out.

The report also contains an address by Mr. R. H. Campbell, director of the forestry branch of the department of the interior on "The New Rocky Mountains forest reserve," an area of 17,900 square miles recently set aside as a reserve largely through the efforts of the commission of conservation and the Canadian Forestry Association.

Fur farming is one of the interesting matters discussed in the section devoted to fisheries and game. Foxes are now being successfully raised for their fur in Western Ontario and in Prince Edward Island. On account of the almost prohibitive price of furs the commission has decided to issue a well-illustrated report on this industry in order that more people may be induced to engage in it. Other matters dealt with in this section are the oyster fisheries, which are in a declining condition, and the shad fisheries, the production of which has fallen off fifty per cent. in the last decade.

A detailed account of the agricultural survey being conducted in every province by the commission is given, as well as a description of the illustration farms now being started in connection with it. Not the least attractive part of this section of the report is a number of diagrams showing graphically just what progress weeds are making against the farmers of each province.

The work being done in taking stock of the water-powers of the country is given in detail, special attention being given to the Athabaska River.

That peat fuel can now be manufactured at a price to compete successfully with coal is the announcement made in the minerals section of the report. The importance of this can be realized when it is known that Canada has 37,000 square miles of peat bogs ranging from five to ten feet in thickness, and that two pounds of average air-dried peat are equal in fuel value to one pound of good hard coal. Other topics treated of in the minerals section are the briquetting of slack coal, the plugging of gas wells, and mine accidents.

WATER SOFTENING.

Some notes on Water Softening were presented by Dr. John F. Meyer to a meeting of the Institution of Municipal Engineers of England.

He remarked that in 1850 Theodor Way established the fact that natural zeolites placed in contact with salt solutions were capable of absorbing the bases contained in the dissolved salts, at the same time yielding up into solution the bases which they themselves contained; and in 1906 Professor Gans, of the Mining Academy of Berlin, took out a patent to manufacture artificial zeolites on a commercial scale, calling his product "permutit." The great outstanding property of permutit, against the natural zeolites, was its greater power of exchanging its own base against other bases.

If a water of a given hardness was passed through a bed of sodium-permutit, the sodium in the permutit was replaced by the calcium and magnesium taken from the water, giving a calcium-magnesium-permutit, while the acid radicals formerly united to the calcium and magnesium in the water united with the sodium which was turned out of the permutit. There would obviously come a time when all the sodium in the sodium-permutit had been replaced by calcium and magnesium from the treated water. When this period was reached it was not necessary to renew the permutit which had become exhausted, but to regenerate or revivify it. This was done by the action of a solution of common salt on the exhausted permutit. The laws of chemical exchange again came into play, the interchange being in this case in the opposite direction, sodium from salt driving out the calcium and magnesium from the exhausted permutit and converting it back to sodium-permutit. It was obvious that all the manufacturer of sodium-permutit plants had to do was to calculate how much sodium-permutit was necessary to take out the hardness of the water per hour and per day, and then to place the permutit into a cylinder.

Many methods had been, and still were, employed to soften water; one precipitated the lime and the magnesia in the water by addition of lime and soda, the other by addition of lime and baryta, and the third by addition of caustic soda. But they all suffered from the disadvantage that in the softening of cold water the precipitation of the lime and magnesia did not take place instantaneously, but only after a comparatively long time. It was also impossible to obtain a complete softening down to zero degrees by any one of the processes. In view of the fact that most of the water supplies in England were of a variable nature, the constituents changing daily, in some cases hourly, it was only by the aid of a fully trained water chemist that it was possible to use any of the above-mentioned processes for softening water down to 4deg. without making it more injurious than the crude water, on the one hand, through an excess of the reagents used, and, on the other hand, by an insufficient quantity of chemicals, resulting in a partially treated and invariably turbid and cloudy water. He had nothing to say against the three processes when they were worked by a trained water-chemist, who made analyses of the water every hour and adjusted the amount of reagents according to his analyses, testing at the same time the composition of his reagents and controlling the softened water. But he condemned the practice of many of those who sold a so-called automatically working lime and soda water-softening plant. The manufacturer found this automatically working apparatus could not produce automatically a soft water, because the crude water changed every day, making it necessary to add different quantities of reagents, and in many cases the automatically worked water-softening plant ended in the works as a storage tank. But the composition of the permu-

tited water was such that these troubles could not occur, because there was no lime and magnesia left in the water. The hardness of the water, however much it might vary initially, was always reduced to O deg., and therefore no incrustation could take place in economizer tubes or boilers.

TELEPHONE EARNINGS AND EXPENSES.

Considerable difficulty was experienced by Mr. J. L. Payne, statistician of the Department of Railways and Canals, Ottawa, in obtaining from rural telephone companies a statement of revenue and operating expenses, and the information under those heads is not quite complete. The requirements of the departmental schedule were neither complicated nor elaborate; yet they were in many instances misunderstood. As far as possible these omissions were adjusted by supplementary returns, and it is believed that little difficulty will be experienced hereafter in this regard.

The gross earnings reported amounted to $10,068,220.03, and the operating expenses to $6,979,045.06. The ratio of operating expenses to gross earnings was 69.32. The net earnings, or the immediate difference between gross income and expenditure for operation—without taking account of proper deductions for interest on bond liability, taxes, etc. —aggregated $3,089,174.97.

It is proposed to draw up a balance sheet for the current year, so simple in character that secretaries of the smaller companies, although unskilled in accounting methods, will not be confused by it. In dealing for the first time with the accounts submitted to the Department, it was not possible to work out a statement which would accurately show the balance available from the year's operations for dividends and betterments.

The gross earnings were equal to $33.25 per telephone, or $14.64 per mile of wire. The operating expenses were equal to $23.05 per telephone, or $10.15 per mile of wire.

Earnings and operating expenses were distributed among the provinces as follows:—

Province.	Earnings.	Operating Expenses.
Ontario	$ 473,992.88	$ 219,102.22
Quebec	6,127,055.81	4,136,083.27
Nova Scotia	415,154.34	313,854.35
New Brunswick	318,992.01	195,155.89
Alberta	439,846.10	250,707.48
Saskatchewan	279,559.29	162,348.34
Manitoba	1,123,446.62	1,032,034.36
British Columbia	856,570.72	643,438.34
P. E. Island	33,602.26	26,320.81
Total	$10,068,220.03	$6,979,045.06

It was found impracticable to make a fair analysis of earnings and operating expenses by companies. The rural systems, for example, are not conducted on a uniform basis. In some instances the method adopted was to assess each member of the organization his proportion of the operating cost for the year, and thus produce a balancing of accounts.

In others, a definite charge for telephone service was made, and the balance as between income and outgo was passed to the credit of the country. In still a considerable number of other cases, the plan followed was to build and equip the line, and pass over the work of operation to one of the major companies. For this operating service a specified charge per subscriber was imposed. The situation was increasingly complicated by the fact that in further instances the local company rented a certain wire mileage from one of the major systems, installed its own telephones, conducted its own central office, and paid for the cost of operating by charging a specific sum to each member.

PRIZE ESSAYS ON THE CREATION OF A SCIENTIFIC BODY OF MEN.

The following circular letter has been sent out to all members of the Canadian Society of Civil Engineers by Prof. C. H. McLeod, the secretary of the Society, under authority of the council. All members are invited to submit essays.

The offer of two prizes for essays on a suggested technical service for Canada, which follows, is designed to accomplish something which should be of very great service to this country. No matter how efficient Canada's representatives in Parliament may be, they cannot be expected to have the experience in technical matters that scientifically trained men possess, in working out, amongst other things, the economic as well as the engineering features in the construction of canals, the deepening of waterways and harbors, the construction of compensating works for obtaining the highest efficiency of available waters in navigable channels, the conserving and distribution of water for domestic purposes on our great western plains. These and many other problems are interrelated, and those called upon to deal with them in order to obtain the greatest efficiency should operate under one head with proper rules for the care and promotion of its members. Such a body could look after the expenditure of public moneys in connection with such works as well as decide as to the needs of the various parts of the country for public buildings, including their character and cost, features that are to a large extent settled to-day upon political considerations.

Canada has strong technical men in this service, but they are like so many loose threads. The present scheme is to work out some organization to gather up these loose threads and make them the basis of a united force, to be reinforced from time to time by some system, thereby bringing into the service of the country the very best men it produces.

In order to arouse an interest in the creation and development of a strong technical and cohesive force to be employed in the public service of Canada, two prizes have been offered—one of two hundred dollars, and the other one hundred dollars—for the two best essays on the subject above named. It is suggested that a brief outline be given of the character and growth of the engineering forces in the service of some other countries, such as Great Britain, France, Germany, and the United States. Then to follow on with an outline for the suggested development of a body of technical men for a Canadian service, which, if adopted, would give the country in time a self-contained force of highly trained scientific men competent to handle with the maximum efficiency the large problems in the development of this country.

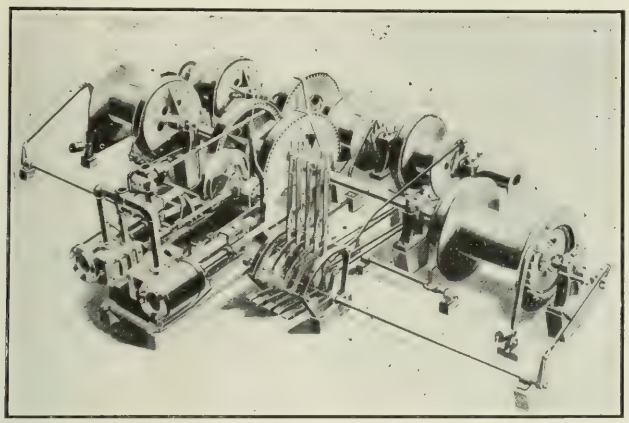
Competitors will not be limited as to length of essays. They should, however, be as concise as possible, sign with an assumed name, accompanied by the real name and address in a sealed envelope. The papers should be addressed to Lieut.-Colonel E. F. Wurtele, Quebec, P.Q., and delivered not later than August 1st next, when they will be examined by three judges whose names will be announced at a later date.

FORESTRY CONVENTION AT VICTORIA, B.C.

On the invitation of the Government of British Columbia, the next convention of the Canadian Forestry Association will be held in Victoria, B.C., September 4-6. While matters relating to Pacific Coast timber will be particularly dealt with, subjects relating to Canadian forests in general will be discussed by leading authorities. The President of the Association, Mr. John Hendry, of Vancouver, in conjunction with the Provincial authorities, is arranging the details.

LARGE ENGINE FOR DREDGE.

There has just been completed the special 10 x 12 double cylinder, 70 h.p., non-reversing engine for gravity-swing, orange-peel, dredge, illustrated in the accompanying photograph. This engine has two main drums to operate the orange-peel bucket and boom, three smaller drums for raising the spuds, and two winch-heads for shore lines. The main drum shaft is 4-7/16 inches in diameter by 28 feet in length. The spud-raising drum shaft is 3-11/16 inches in diameter by fifteen feet long, and is geared to the main drum shaft with bronze-bushed clutch, allowing the spud-raising shaft to be thrown out when not required. The main drums



View Showing Engine.

are operated by regular screw thrusts, the spud-raising drums by internal oscillating cam thrusts. All drums have brake-bands. The distance from centre to centre of the main drums is 23 feet, and the over-all distance of the engine, 30 feet. All friction heads are of cast steel; as, of course, is all gearing. The gear on the main drum shaft is 42 inches in diameter. The shipping weight of the entire engine is about 26,000 lbs. This engine was made by the Clyde Iron Works, of Duluth, Minnesota, to the special order of Doullut and Williams of New Orleans, and is a larger size of the same engine which was originally designed and made by the same Company, to the order of the Phillips Land Company.

PROGRAMME TWENTY-SECOND ANNUAL CONVENTION CANADIAN ELECTRICAL ASSOCIATION.

The annual meeting will be held at the Chateau Laurier, Ottawa, Wednesday, Thursday and Friday, June 19th, 20th and 21st, 1912.

Wednesday, June 19th.

10.00 a.m.—Opening session. Address of welcome by His Worship the Mayor, at Chateau Laurier. Minutes. President's address. Secretary-treasurer's report. Correspondence. General business.

11.30 a.m.—Report of Membership Committee, D. H. McDougall, chairman. Report of Meter Committee, L. V. Webber, chairman. Report of Commercial Committee, Thomas F. Kelly, chairman.

12.30 a.m.—Adjournment.

Afternoon.

2.00 p.m.—"Recent Developments in Lamps and Reflectors," J. G. Henninger, illuminating engineer, National Electric Lamp Association. "The Influence of Ice on Water Power Development," Professor H. T. Barnes, D. Sc., F.R.S., McGill University, Montreal. "Distributing Systems for Outlying Districts and Smaller Plants," S. Bingham Hood, Toronto Electric Light Company.

Evening.

7.45 p.m.—Special electric cars will leave Chateau Laurier for Victoria Hotel, Aylmer, where an informal dance and garden party, tendered by the city of Ottawa, will be held. Supper will be served at 11 p.m. and cars will be waiting for return trip at 12 p.m.

Thursday, June 20th.

10.00 a.m.—"Watthour Meters—Past and Present," C. W. Baker, Canadian Westinghouse Company. "New Business," Thomas F. Kelly, Hamilton Electric Light and Power Company. Report of Committee on Rates and Forms of Contract, Parker H. Kemble, chairman.

12.30 a.m.—Adjournment.

Afternoon.

2.00 p.m.—Executive session (Class "A" and "B" members) for election of officers.

2.30 p.m.—Automobile drive from Chateau Laurier to various points of interest in the city, including government system of parks and drives, the Experimental Farm, Governor-General's residence, etc. Light refreshments will be served at some point on the route.

Evening.

8.00 p.m.—Banquet at Chateau Laurier for the registered members of the C.E.A. and guests, and the local committee with ladies accompanying them. Tickets will be furnished by the secretary on application.

Friday, June 21st.

10.00 a.m.—"Power Factor—Its Influence and Effect," D. H. Ross, Wagner Electric Manufacturing Company. "Commercial Electric Heating," McAllister Moore, Belleville. "Underground Construction" (illustrated by moving pictures), G. M. Gest, New York.

12.30 a.m.—Adjournment.

Afternoon.

2.00 p.m.—Report of Committee on Uniform Accounting, D. R. Street, chairman. Report of Public Policy Committee, W. C. Hawkins, chairman. Report of Committee on Standardization of Line Construction, R. G. Black, chairman. Naming of Standing Committee. Next place of meeting. Unfinished business.

3.00 p.m.—Special electric cars will leave Chateau Laurier for baseball grounds, where a game will be played between two C.E.A. teams, one representing the manufacturers, and the other the operating companies.

Evening.

8.00 p.m.—Smoking concert in the Chateau Laurier.

Mr. A. A. Dion, Ottawa, is the president and Mr. T. S. Young, 220 King Street West, Toronto, is the secretary-treasurer.

PERSONALS.

MR. E. O. FUCE, engineer of the municipality of Galt, Ont., has handed his resignation to the town council. He intends to join Mr. Walter Scott in Calgary, Alta.

MR. CUTHBERT C. WORSFOLD has been appointed resident engineer of the Department of Public Works for the province of British Columbia. Mr. Worsfold has been engaged for the past fourteen years as chief assistant to the late Mr. Keefer. He was born at Dover, England, and came to Victoria many years ago, after graduating.

MR. W. ALMON HARE B.A.Sc., president of the Hare Engineering Company, Limited, Toronto, has left for England and the Continent on a business trip. He will be absent about six or seven weeks.

MR. LEWIS C. RANDOLPH has been recently appointed editor of The Canadian Industrial Review, a bright little monthly published by the Canadian Fairbanks-Morse Company, Limited, at 444 St. James St., Montreal. The first number edited by Mr. Randolph is the May issue just received, in which a number of very desirable changes have been made from the former style of the paper. The Canadian Industrial Review is one of the most valuable house organs printed in Canada, and is well worthy of regular perusal by every engineer and contractor.

MR. COLIN H. ADAMS, of Messrs. Adams-Hydraulics, Limited, Sewage Disposal Specialists and Engineers, York, London, etc., in consequence of the large contracts now on hand has sailed for Canada, and will be pleased to call upon civil and municipal engineers who have sewage schemes in hand. Communications addressed to him, c/o Messrs. F. Hankin & Company, 201, Coristine Building, Montreal, will be attended to.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithaca, N.Y.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN FORESTRY ASSOCIATION.—Convention will be held in Victoria, B.C., Sept. 4th-6th. Secy., James Lawler, Canadian Building, Ottawa.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta.; Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President, J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Jas. Anderson, Gen. Mgr., Sandwich, Windsor and Amherst Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close	Noted in issue of
6-17—Electric Generating Station Equipment, Bassano, Alta. ....(S.)	5-30

(Bassano specifications also on file at the office of The Canadian Engineer, Montreal, and the Engineers, Messrs. Bowring & Logan, 322 Donald St., Winnipeg).

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Bassano, Alta., electric generating machinery	June 17.	May 30.	74
Berlin, Ont., waterworks improvements		May 23.	72
Boswell, B.C., pile bent wharf	July 2.	June 6.	68
Brantford, Ont., sewer pipe	June 15.	June 6.	80
Buchanan, Sask., school	June 15.	June 6.	68
Carr's Brook, N.S., breakwater wharf	June 27.	June 6.	68
Edmonton, Alta., pile wharf	June 17.	May 23.	60
Gananoque, Ont., drill hall	June 22.	June 6.	68
Kemptville, Ont., public building	June 13.	June 6.	67
Kerrisdale, B.C., steel pipes	June 24.	June 6.	67
Lawrenceville, B.C., bridge	June 15.	June 6.	67
Lethbridge, Alta., paving	June 14.	May 30.	61
Maisonneuve, Que., post office building	June 17.	June 6.	67
Moore Park, Ont., sidewalks	June 17.	June 6.	80
Moose Jaw, Sask., light standards	June 14.	May 30.	62
Newmarket, Ont., school building	June 15.	May 30.	62
Ottawa, Ont., station and other buildings	June 14.	May 30.	72
Ottawa, Ont., mail contract	June 21.	May 23.	76
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., sale of steamer	July 3.	June 6.	78
Ottawa, Ont., fishing protection vessel	June 17.	Apr. 18.	74
Ottawa, Ont., design and construction of steamship	June 30.	May 16.	76
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Port Arthur, Ont., paving	June 24.	June 6.	80
Quebec, Que., leasing of water-powers	June 26.	May 2.	72
Regina, Sask., Torhill reservoir	June 21.	June 6.	78
Regina, Sask., supply of steel, cement, and castings for reservoir	June 14.	June 6.	78
Saskatoon, Sask., garbage incinerator	June 25.	May 2.	74
St. Thomas, Ont., sewers; sewer pipe	June 19.	June 6.	80
Toronto, Ont., steam heating, pumping station	June 18.	June 6.	68
Tisdale, Sask., storm water sewers	June 15.	May 30.	62
Vancouver, B.C., bridge construction	July 8.	May 30.	74
Yarmouth, N.S., dredging	June 13.	June 6.	68

TENDERS.

Arden, Man.—Tenders for the erection of a steel truss bridge, 70 ft. clear span, over the Grassy River, will be received up to noon of July 3rd. Plans and particulars at the Department of Public Works, Winnipeg, and at the office of M. E. Boughton, secretary-treasurer, Lansdowne, Arden, Man. (See advt. in The Canadian Engineer).

Fort William, Ont.—Tenders for the construction of sewers of 4,200 feet, in the Town of Fort Frances, Ont., will be received until June 17th, 1912. Specifications may be seen at the office of J. W. Walker, Clerk.

Fort Wiliam, Ont.—Tenders for the construction of a concrete sewer on Wellington Street will be received until July 5th, 1912. Plans, etc., can be obtained at the office of John Wilson, City Engineer.

Kerrisdale, B.C.—Separate tenders will be received until June 24th, 1912, for the supply of valves, special castings and hydrants required for water supply of the Municipality of Point Grey, B.C. Particulars may be obtained at the office of the engineers Cleveland and Cameron, 506 Winch Bldg., Vancouver. H. Floyd, Clerk Municipal Council, Kerrisdale.

Merritt, B.C.—Tenders addressed to the City Clerk, Merritt, B.C., will be received up to noon of June 15th, 1912, for pipe, specials, valves and hydrants. Plans and specifications may be seen at the office of Dutcher, Maxwell and Co., 319 Pender Street, Vancouver, B.C.

Merritt, B.C.—Tenders addressed to the City Clerk, Merritt, B.C., will be received up to noon of June 15th, 1912, for steam engine generator sets, pumps, transformers, transmission poles and arms. Plans and specifications may be seen at the office of Dutcher, Maxwell and Co., 319 Pender Street, Vancouver, B.C.

New Westminster, B.C.—The corporation invites tenders for paving a number of streets until June 17th, 1912. Tenders will be received for the following types of pavement: Asphaltic, concrete, bitulithic, hassam, vitrified bricks, wood blocks (creosoted). Plans and specifications can be obtained from J. W. B. Blackman, City Engineer. W. A. Duncan, City Clerk, City Hall, New Westminster.

Niagara Falls, Ont.—The Spirella Company of Canada, is about to make a large addition to their factory premises at Niagara Falls, Ont. W. Redpath of Builders' Exchange, Buffalo, N.Y., Architect and Engineer, wants tenders from leading reinforced concrete contractors at once. Particulars can be obtained from W. Redpath.

Oshawa, Ont.—The time for receiving tenders for the construction of 25,000 sq. ft. of concrete sidewalks, has been extended to June 19th, 1912. Frank Chappell, C.E., Town Engineer. (See advt. in The Canadian Engineer).

Ottawa, Ont.—Tenders for an addition and alterations to Public Buildings, Barrie, Ont., will be received at the Department of Public Works, Ottawa, until June 27th, 1912. Plans, etc., can be seen at the office of Mr. Thomas Hastings, Clerk of Works, Postal Station F, Yonge Street, Toronto, at the Post Office, Barrie, Ont., and at the Department of Public Works, Ottawa.

Ottawa, Ont.—The Department of Militia and Defence, Ottawa, are calling for tenders for the construction of new stables at Tete de Point Barracks, Kingston, Ont., up to noon of June 23rd, 1912. Specifications may be seen and full particulars obtained at the offices of the officer commanding, 3rd Divisional Area, Kingston, Ont., and the Director of Engineer Services, Headquarters, Ottawa.

Ottawa, Ont.—Tenders for interior fittings, Post Office, Customs and Inland Revenue, Seaforth, Ont., will be received until June 19th, 1912. Plans and specifications may be seen on application to Mr. R. Wright, Clerk of Works, Seaforth, Ont.; Mr. T. A. Hastings, Clerk of Works, Postal Station F., Toronto, and at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the erection of an operating house (Type No. 3) in connection with a wireless telegraph station at Point Edward near Sarnia, Ont., will be received until noon on July 1st, 1912. Plans, etc., at the office of Superintendent Radio-Telegraph Branch, Department of Naval Service, Ottawa, or at the office of the Post-Master, Sarnia, Ont. G. J. Desbarats, Deputy-Minister, Department of Naval Service, Ottawa.

Ottawa, Ont.—The Department of Public Works, Ottawa, is open to receive tenders for the supply of coal for the Public Buildings, Ottawa, until June 17th, 1912. Combined specification and tender can be obtained and form of contract seen at the office of the Secretary, R. C. Desrochers, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for the erection of two 185 feet housing masts in connection with a wireless telegraph station at Point Edward, near Sarnia, Ont., will be received at the office of G. J. Desbarats, Deputy-Minister of the Naval Service, Ottawa, until July 1st, 1912. Full particulars may be obtained at the office of the Superintendent Radio-Telegraph Branch, Department of the Naval Service, Ottawa, or at the office of the Post Master, Sarnia, Ont.

Ottawa, Ont.—Tenders for interior fittings Post Office, Customs and Inland Revenue at Humboldt, Sask., will be received until June 24th, 1912. Plans and specifications to be seen on application to Mr. W. Driver, Clerk of Works, Humboldt, Sask.; Mr. W. T. Mollard, Clerk of Works, Regina, Sask., and at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Port Arthur, Ont.—The Board of Education is calling for tenders for a 12-room school. Estimated cost $70,000. Messrs. Hood & Scotts, architects.

St. Catharines, Ont.—Tenders will be received by the Board of Works up to noon of July 3rd, 1912, for the construction of Berryman Avenue Trunk Sewer. R. D. Brown, Esq., City Engineer, St. Catharines. (See advt. in The Canadian Engineer).

St. John, N.B.—The city of St. John invites tenders for the following works, viz.: Excavation, backfill and cartage for water mains, in a number of streets and also the laying of bituminous concrete sidewalks in several streets. Plans and specifications are to be seen in the office of the City Engineer, Room No. 5, City Hall. R. E. Wigmore, Commissioner Water and Sewerage, M. E. Agar, Commissioner Public Works, St. John, N.B.

Toronto, Ont.—Tenders for the construction of Section No. 12, High Level Interceptor, will be received up to noon of July 2nd, 1912. Plans, etc., can be obtained at the office of the Acting City Engineer, Toronto. G. R. Geary, (Mayor), Chairman, Board of Control. (See advt. in the Canadian Engineer).

Toronto, Ont.—Tenders for the erection of a dormitory building, excepting heating, plumbing and lighting, on the grounds of the Institution for Deaf and Dumb, Belleville, will be received up to noon of June 17th, 1912. Plans and specifications can be seen at the office of H. F. McNaughten, Secretary, Department of Public Works, Ontario, Toronto.

Winnipeg, Man.—Tenders for the installation of a heating and ventilating plant in the Laura Secord School will be received at the office of the Winnipeg School Board, until June 18th, 1912. Plans, etc., at the office of J. B. Mitchell, Commissioner of School Buildings, School Board Offices. R. H. Smith, Secretary-Treasurer, W.P.S.B.

Winnipeg, Man.—Tenders will be received up to noon of June 17th, 1912, for the manufacture and delivery f.o.b. Winnipeg, of the following supplies, viz: 100 fire alarm box holders; 75 police box holders; 80 fire alarm signal lamp supports. Plans, etc., may be obtained at the office of the City Electrician, City Hall. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders for the erection of a stone and brick school on the Lord Selkirk Site, will be received until June 18th, 1912. For plans, etc., apply to J. B. Mitchell, Commissioner of School Building, School Board Offices, Winnipeg.

Winnipeg, Man.—Tenders for the manufacture, delivery and installation complete of 31,000 k.w. transformers will be received up to noon of June 14th, 1912. Full particulars may be obtained at the office of the City Light and Power Department, 54 King Street. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders are being called for the construction of another sixty-five miles of the Hudson's Bay Railway, and tenders covering the remainder of the road will be called for very shortly.

CONTRACTS AWARDED.

Berlin, Ont.—The Waterworks Commission has awarded the contract for constructing a million-gallon reservoir in connection with the new $100,000 extension plant to Mr. John Paterson, of St. Mary's, at a cost of $15,450. A new $500,000 standpipe will also be erected.

Gosford, Que.—Messrs. P. Lyall and Sons, Transportation Building, Montreal, have received the contract for the demolition of old buildings and the erection of the Montreal City Hall Annex, in Gosford. Contract price, $649,000.

Fredericton, N.B.—Another contract for the construction of the St. John Valley Railway, the line from Woodstock to Meductic, has been awarded to Messrs. John S. Scott & Company, of Fredericton.

London, Ont.—The contracts for the construction of the factory of the Dominion Abattoir, Limited, at Pottersburg, have been awarded by Moore and Munroe, architects. Joshua Garratt will do the brick work, Tambling and Jones the carpenter work, and the London Foundry Company the iron work.

Montreal, Que.—Tenders for the excavation and foundation work in connection with the new High School building, were opened from the following firms:—John Quinlan and Company, $235,000; Reid, McGregor & Reid, $254,000; E. G. M. Cape, $281,000; P. Lyall and Sons Construction Company, $295,000; Geo. A. Fuller Company, $284,000. The tender from John Quinlan and Company, for $235,000, was accepted. Architect, Mr. Wm. Maxwell.

Moose Jaw, Sask.—The contract for the erection of St. Andrew's Church has been awarded to Mr. A. B. Anderson, of Winnipeg, his tender for $120,695 being the lowest received.

Outlook, Sask.—This town has just placed a contract with the British Canadian Engineering and Supply Company, Limited, of Winnipeg, for a 72 brake horse-power Ruston Proctor producer gas engine and plant, together with a Westinghouse generator.

Saskatoon, Sask.—The city council have closed a contract with Messrs. Stone and Webster, a Boston engineering and contracting company, for the construction of the street railway and the financing of the undertaking for a year.

Toronto, Ont.—Messrs. Siemens Brothers' Dynamo Works have received a repeat order for the city of Regina for a 400 K.W., 550/600 Volt, 450 R.P.M., direct current, compound wound generator with commutation poles. The generator will be direct coupled to a Belliss & Morcom vertical high-speed engine.

Toronto, Ont.—An order for a 150 K.W., 475 R.P.M. compound wound, direct current, 3-wire generator for the Winnipeg General Hospital, has been placed with Messrs. Siemens Brothers' Dynamo Works. The generator will be direct coupled to a high-speed vertical engine. A switch panel for controlling the generator is also being supplied by Siemens.

Toronto, Ont.—A repeat order from the city of Port Arthur, Ont., for a 500 K.W., 450 R.P.M. motor generator set, has been received by the Siemens Brothers' Dynamo Works. The motor is of the synchronous type, having an output of 750 b.h.p., on a 3-phase, 60-cycle, 2,200 volt system. The generator has an output of 500 K.W., 550/600 volts, is compound wound, and has commutation poles with Siemens two-piece commutator. A two-panel switchboard is also being supplied to control the above set.

Toronto, Ont.—Messrs. Siemens Bros.' Dynamo Works have received the order for the following apparatus for the city of Edmonton.

Dolarway Pavement

"It is permanent because it is concrete."

The Last Word In Street Pavements

The Dolarway Pavement is popular with City Officials, Highway Engineers and Property Owners because:

It is low in first cost.
Its maintenance cost is lower than that for any other permanent form of Pavement.
No paving plant is required to either construct or maintain it.
It is noiseless, dustless and resilient.
Its traction qualities for both the Horse and the Automobile are of the best.

For full particulars address

DOLARWAY PAVING COMPANY

95 Liberty Street, New York City 510 Title & Trust Bldg., Chicago, Ill.

Applying Dolarway Bitumen on Concrete Base, Central Park, N.Y. City.

1—2,000 K.W., 3,600 R.P.M., 3-phase, 60 cycle, turbo generator for direct coupling to a Willans & Robinson turbine.
1—750 K.W., 280 R.P.M., direct current, 500/575 volt compound wound generator with commutation poles for direct coupling to a Belliss & Morcom high speed vertical engine.
1—425 H.P., 3-phase, 60 cycle, 450 R.P.M., slip-ring motor with short circuiting and brush lifting device.

Medicine Hat, Alta.—The contract for the Ogilvie Mills has been let to Messrs. James Stewart & Company, of Chicago. The iron is to be supplied by the Alberta Rolling Mills.

Vancouver, B.C.—A report states that contracts for construction for a $400,000 steam auxiliary plant on Vancouver Island have been recently awarded to Messrs. C. C. Moore & Co., of Seattle and San Francisco. W. H. Haylitt, purchasing agent.

RAILWAYS—STEAM AND ELECTRIC.

Guelph, Ont.—The management of the Guelph Radial Railway decided to purchase a snow sweeper at a cost of $4,000.

LIGHT, HEAT AND POWER.

Brockville Ont.—A member of the Hydro-Electric Power Commission, field staff, is at present engaged in the vicinity of Brockville and Kingston, going over the different routes, to select a route and station site, for the proposed 66,000 volt line from a supply point near Morrisburg. He is also looking up a route and station site for the 13,200 volt supply lines between Prescott, Cardinal, Morrisburg and Lyn.

Moose Jaw, Sask.—The municipal council has resolved to place an order with the Canadian General Electric Company for a 1,000 k.w. three phase generator to be shipped at an early date.

Ridgetown, Ont.—The ratepayers of this municipality voted in favor of the purchase of the electric light plant at a price of $10,500.

Saskatoon, Sask.—The ratepayers voted their approval of spending $175,000 on electric light and power machinery, and $80,000 for extension to the distributing system.

Saskatoon, Sask.—A report prepared by the civic electrician shows that during May 241,539 k.w. of electricity were generated by the city's power plant. This is an increase of 68 per cent. over the amount generated in the same month last year.

53,357,442 gallons of water were pumped at the city's pumping station, or an increase of 76 per cent. on the corresponding month of last year.

These figures represent an increase in the income for May, 1912, of 40 per cent.

Welland, Ont.—A report has been presented to the council and that body will consider a municipal lighting plant operated by the Hydro-Electric Commission.

GARBAGE, SEWAGE AND WATER.

Edmonton, Alta.—The water pumping facilities of this city are to be increased by the addition of a ten-million gallon and a six-million gallon unit.

Ingersoll, Ont.—The cost of the proposed sewage system will be about $60,000. Mr. W. Chipman, of Toronto, is engineering the project.

Saskatoon, Sask.—The ratepayers voted in favor of spending $50,000 on the construction of a storm sewer.

Toronto, Ont.—Acting City Engineer Powell has stated in a report that the cost of the proposed extension to the filtration plant will be $877,000. The work includes a second plant of thirteen filters an additional steel intake and a chlorination plant.

Kerrisdale, B.C.—There is a probability of the council calling for tenders for a water supply from Point Grey reservoir. Messrs. Cleveland and Cameron are the engineers of this proposed work.

BUILDINGS AND INDUSTRIAL WORKS.

Berlin, Ont.—The members of the Berlin Tuberculosis Association will ask the municipal council for a grant of $15,000 for the purpose of purchasing property near Freeport on which will be erected a suitable sanitarium.

Berlin, Ont.—The Board of Health will reccommend that the municipal council pass a by-law calling for the erection of a civic abattoir.

Edmonton, Alta.—A building permit has been issued, for the new building of the Edmonton Brewing and Malting Company, to be erected on 21st Street. This building will be of concrete, steel, and brick construction, and practically fireproof. The plant when completed will comprise the most modern equipment, and will entail an expenditure of approximately $450,000.

Edmonton, Alta.—The City Commissioners have let contracts for a six story office building to cost $225,000, for the accommodation of the officials of the various civic departments.

Montreal, P.Q.—Plans have been prepared for the erection of a large commercial building for the A. Sommer Company. It will be ten stories in height.

Moose Jaw, Sask. — The managers of St. Andrew's Church have been instructed by the congregation to proceed with the erection of a new church building at a cost of $120,695.

New Glasgow, N.S.—A subsidiary company of the Nova Scotia Steel and Coal Company, called the Eastern Car Company, was formed here recently with capitalization of $2,500,000. It is intended to build steel freight cars near the present mills, the works having a capacity of 25 per day. A master car builder, formerly connected with the American Car and Foundry Company, of Detroit, has been engaged and is now preparing plans and estimates, and it is expected to break ground within the next ten days.

Port Arthur, Ont.—The Drydock & Shipbuilding Company will construct the following buildings this season:—power house 50 ft. x 105 ft.; warehouse 60 ft. x 120 ft.; joiner shop, 60 ft. x 160 ft. A syndicate will erect an eight-story office building, estimated cost $500,000. Architect is David R. Brown, of Montreal. Jas. Whalen is interested.

Regina, Sask.—The municipal council are considering the matter of erecting a collegiate institute building at a cost of $100,000.

Saskatoon, Sask.—The ratepayers will vote on a proposition which calls for the granting of a free site and other concessions to the management of the Quaker Oats Company who propose to erect a milling plant in this city.

Saskatoon, Sask.—Mr. F. R. MacMillan is considering the details of construction previous to calling for tenders for the erection of a new department store building.

Stratford, Ont. — The congregation of the Lutheran Church, Berlin, Ont., propose the erection of a church building on property recently acquired at the corner of Church and Benton Street.

Palmerston, Ont.—Messrs. Taylor, Scott and Company, of Toronto, who have recently purchased the woodworking establishment of Major Wooldridge, intend erecting a substantial addition on the present premises.

Thunder Bay District.—The Government will locate a prison farm in Neebing Township. The buildings, etc., will cost about $50,000. Dr. Bruce Smith, of Toronto, is superintendent of government institutions.

Toronto, Ont.—The Toronto Harbor Commissioners contemplate spending about $5,000,000 on the improvement of the Ashbridge's Bay district, and in a few days it is probable the plans for the big undertaking will be passed by the Commissioners.

Vancouver, B.C.—Preliminary work, preparatory to starting construction on the new Canadian Pacific Railway depot, has commenced. Messrs. Westinghouse, Church & Kerr, of New York, are the engineers for this project.

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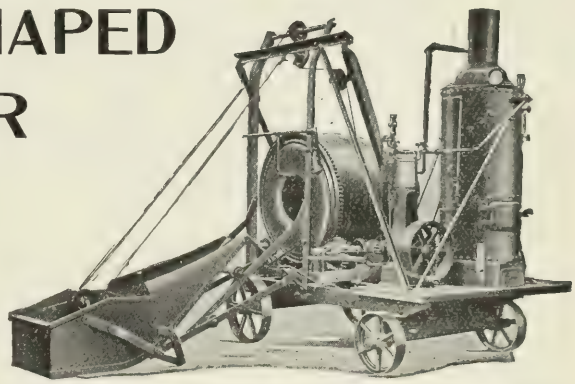

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BRIDGES, ROADS AND PAVEMENTS.

Montreal, P. Q.—The municipal controllers are considering a report on a proposed bridge between Montreal and St. Helen's Island. The cost of the structure is estimated at $10,000,000.

Oshawa, Ont.—The time for receiving tenders for cement paving has been extended to June 19th. (See advt. in The Canadian Engineer.)

Province of British Columbia.—A delegation from this province will meet in Ontario to press the matter of the construction of a bridge to Vancouver Island. Should this receive favorable attention from the Government the cost would be about $20,000,000, and it would be one of the largest bridge structures in the world.

FIRES.

Cobalt, Ont.—A large section of the business block of this town was damaged by fire. The loss is estimated at $40,000.

Montreal, P.Q.—The plant of the Peck Rolling Mills was damaged by fire to the extent of $25,000.

Penetanguishene, Ont.—Considerable damage was caused by fire to the plant and mills of the C. Beck Manufacturing Company. Several new pieces of machinery are destroyed.

Portage la Prairie, Man. — The round-house, telegraph office, store-room, oil-house and paint shop of the Grand Trunk Pacific Railway were gutted by fire.

Prince Albert, Sask.—The buildings of the Prince Albert Foundry Company were damaged to the extent of $21,000 by fire.

CURRENT NEWS.

Berlin, Ont.—Mr. J. Walters, of Chicago, Ill., U.S.A., has opened negotiations with the municipal council with a view of establishing a wood pulp manufactory.

Kerrisdale, B.C.—The extent and cost of the relative civic works which have been or are being carried out this year are as follows:—Clearing and grubbing, 10.1 miles, cost $17,000; clearing, grubbing and contour grading, 6.5 miles, cost $69,000; box drains, 4,500 feet, cost $900; macadamizing, 12 miles, cost $100,000; road planking, 1 mile, cost $3,700; wooden sidewalks, 5 miles, cost $4,700; cement sidewalks, 0.3 mile, cost $1,100; bithulithic paving, including curbs, 2.6 miles, cost $66,000; sewers, 13 miles and sewer connections, 3 miles, cost $358,000—making a total of $642,400.

Medicine Hat, Alta.—The municipal authorities are about to open a milk testing laboratory.

New Glasgow, N.S.—The first forging by steam hydraulic presses ever attempted in Canada was successfully carried out recently at New Glasgow before the directors of the Nova Scotia Steel and Coal Company.

New Westminster, B.C.—The ratepayers will be asked to vote on by-laws involving an expenditure of over $1,000,000. This work involves improvements to the harbor, water works extension, erection of a new reservoir, construction of a new hospital, construction of a new police station, construction of a storehouse and a municipal gas plant.

St. John, N.B.—Messrs. Norton Griffiths Company, contractors for the harbor improvements of St. John, have filed plans at Ottawa for the construction of a large drydock. The estimated cost of this work is placed at $4,000,000.

Welland, Ont.—A report from this municipality regarding building is as follows:—Building permits for month of May, 1912, are $30,968; building permits for month of May, 1911, no record; total for year to date this year is $104,873; total for year to date last year, no record.

Western Canada.—Owing to the shortage in cement the Government has reduced the duty on this article by 50 per cent.

ENGINEERING NOTES.

Edmonton, Alta.—The operation of the municipal street railway for the half-year still shows a small deficit.

Edmonton, Alta.—The operation of the municipal electric light department for the past six months shows a profit of $57,000.

Edmonton, Alta.—The operation of the municipal telephone system for the past six months shows a profit of about $8,000.

Montreal, P.Q.—A brick chimney, the property of Messrs. R. McFarlane & Sons, was successfully straightened by a delicate operation. The structure has a height of 129 feet, and recently sagged until the top was four feet six inches forward of the bottom. Four layers of brick were taken from the left side of the chimney and after each layer had been taken out the chimney was propped up and allowed to come down the three inches. This is the first time that such an operation has been successfully carried out in Canada. It has been performed several times in England.

Northern Ontario.—A party with Mr. W. J. Donaldson, at the head has left Cobalt and are on the way to Clark Island, James Bay, for the purpose of working large iron deposits staked out five years ago by Mr. Curran and Dr. Adams.

Toronto, Ont.—A delegation of marine men from Great Britain, France, Germany, Denmark, Russia, Belgium, Spain, Italy, Switzerland, Norway, Roumania, Hungary, Egypt, Mexico, Cuba, Brazil and the United States, visited the harbor of Toronto on June 13th. These are the delegates from the International Congress of Navigation which met recently in Philadelphia, P.A., U.S.A.

RAILWAY SHOPS AT TRANSCONA, MANITOBA.

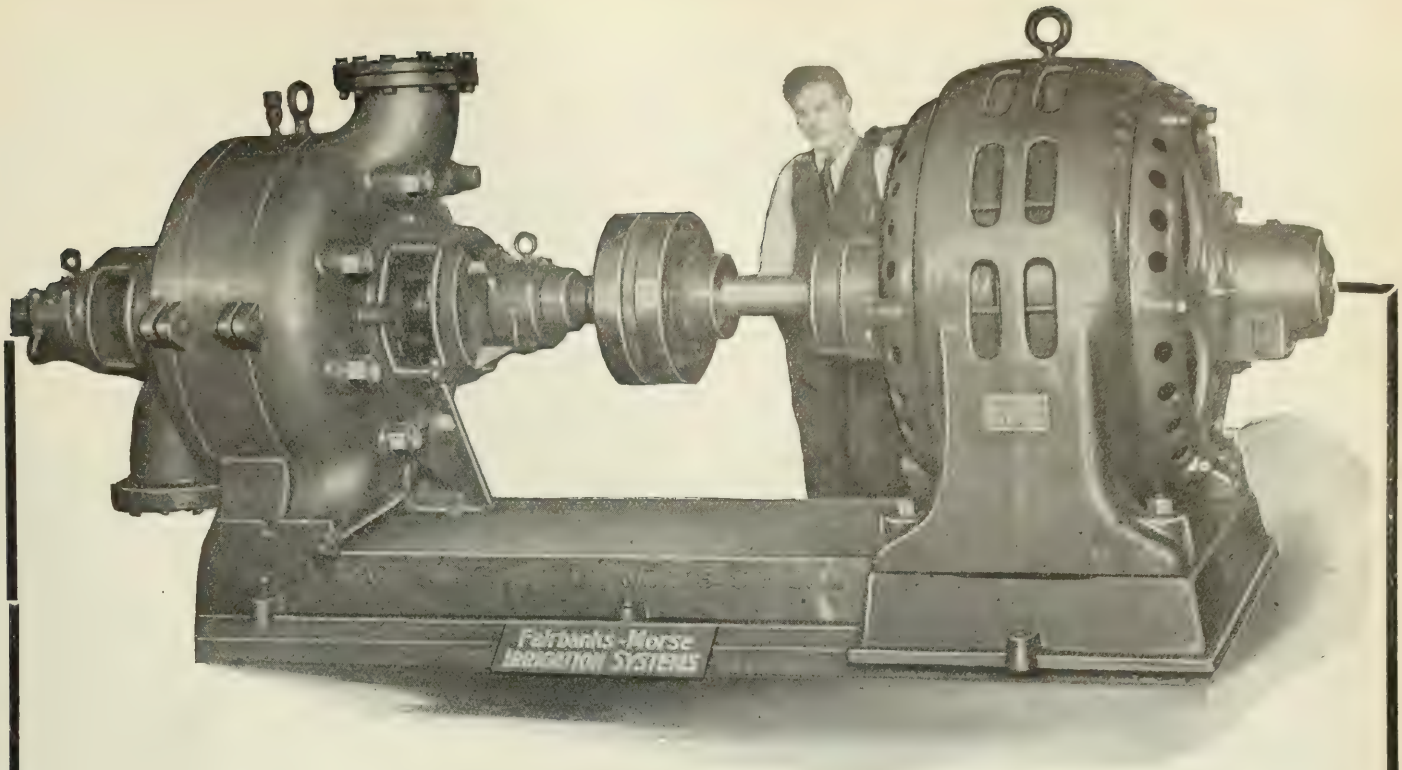
The Grand Trunk Pacific shops at Transcona, Man., which were opened for operation on June 1, are among the largest, and are said to be the most modern and the most completely equipped on the continent.

The locomotive shops are 600 feet long with an additional section at the east end for use as a boiler-making room, which is 200 feet in length. Running the entire length of the building is a large 120-ton travelling crane with a smaller 10-ton crane on a track below it. On the south side of the building are also two ten-ton travelling cranes, while on the ground floor are a number of machines to be used in locomotive construction and repair; hydraulic presses and hammers, etc., steel working machines.

One of the most interesting machines in this shop is an immense eighteen-foot gap riveter, which is capable of handling the largest locomotive boilers and riveting them from end to end without turning over. The heaviest, perhaps, is the hydraulic accumulator in the boiler room which supplies hydraulic pressure to the other machines at a pressure of 1,500 pounds per square inch, and weighs about sixty tons. In these shops, together with the foundry and other buildings, it will be possible to build not only complete locomotives, but freight and passenger cars.

Construction is being rapidly pushed on the car shops and the steel skeletons are rapidly taking form. They will be 600 by 225 feet in area and will build or repair all kinds of wood and steel frame cars. At the west end the framework of two coach shops has already been erected where the first-class sleepers and diners to be used on the new road will be built.

The proprietors of several hastily constructed sheet metal buildings in Edmonton have experienced trouble by legal charges which name them as breakers of the building laws. An effort will be made by several merchants to determine the exact status of persons erecting buildings of this material, and will contend the point as to whether or not galvanized tin or sheet iron which forms the walls of the many movable stores and shoe-shining parlors along First and other streets, can be considered non-combustible.



The Largest Direct Connected Centrifugal Pumping Unit in British Columbia.

The Vancouver Power Company have recently installed at their works at Coquitlam Dam, B.C., the largest direct connected centrifugal pumping unit in British Columbia. This outfit is to operate in parallel with a number of other pumps that are to furnish water under pressure for sluicing into place the material for their new dam.

This pump is a 10-inch, class "F," two-stage centrifugal, with bronze inpellers and renewable bronze diffusion vanes. It has a normal capacity of 1833 imperial gallons per minute when operating at 1160 r.p.m. against a total head of 355 feet or an equivalent pressure of 154 lbs. per square inch. It is mounted on a common sub-base with a 300 h.p. type "B," Fairbanks-Morse squirrel cage, induction motor, 2200 volts, 60-cycle, 3-phase, 1160 r.p.m. at full load being direct connected thereto by means of a flexible leather link coupling

The motor possesses a feature in rotor construction that is unique. The end rings are welded on to the rotor bars by a new process, making a perfect joint, free from the troubles common to the purely mechanical or riveted joint, such as oxidation, working loose, and solder-throwing. This improvement marks a long step forward in the elimination of rotor trouble.

Our Vancouver Branch supplied and assembled this complete pumping unit. We are in a position to quote on the necessary equipment for any pumping requirements on receipt of specifications.

The Canadian Fairbanks-Morse Co., Limited

Fairbanks Standard Scales, Fairbanks-Morse Gas Engines
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CALGARY, SASKATOON, VANCOUVER, VICTORIA.

CORRECTION.

In our issue of May 23rd we published an item under the heading of "Contracts Awarded" to the effect that the Niagara Falls Canning Company were about to increase their plant by the expenditure of $100,000 for an addition. We are informed from Niagara Falls that the item referred to the Sanitary Canning Company, and that the work will involve an expenditure of $60,000.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16564—May 21—Approving revised location of C.N.O. Ry. (Toronto-Ottawa Line) west of Newburgh, Twp. of Camden, Ct. Addington, Ont.

16565—May 21—Authorizing C.N.O. Ry. to cross public road between Lots 20 and 21, Con. 2, Twp. of Thorah, Ontario.

16566—May 21—Authorizing G.T.P. B.L. Co., and C.P.R., to operate over interlocker at crossing of Melville-Regina Branch of G.T.P. B.L. Co., and C.P.R. Bulyea Branch.

16567—May 21—Authorizing C.N.O. Ry. to construct bridge over Otter Creek, at mileage 204 from Toronto, Ontario.

16568—May 22—Directing C.P.R. to install within 90 days electric bell at Main Trail near Hesperus, Alta. 20 per cent. from Railway Grade Crossing Fund. (Lethbridge Subdivision).

16569—May 15—Approving diversion and crossings in R. M. Purdue, No. 346, Saskatchewan, across C.P.R.

16570—May 22—General Order Fire Prevention on Railways.

16571—May 21—Authorizing St. Railway, Fort William, Ont., to operate cars over crossing of C.P.R. at Pacific Avenue.

16572—May 21—Approving plan "A" for subway under C.P.R. at 9th Avenue, East Calgary, Alta. (C. & E. Branch C.P.R.).

16573—May 21—Authorizing C.P.R. to cross with its Swift Current Northwesterly Branch (formerly Swift Current to Brooks Branch), 25 highways and approving location mileage 78.00 to 111.14.

16574—May 21—Authorizing C.P.R. to construct extension to spur of Dominion Gypsum Co., Ltd., Winnipeg, Man.

16575—May 22—General Order Re Forged Steel Wheels on Tender Trucks.

16576—May 22—Authorizing C.P.R. to construct cement foot subway under its tracks at George St., Smith's Falls, Ontario.

16577—March 8—Directing C.N.O. Ry. to maintain and erect a flag station at the eastern extremity of Deaf & Dumb Institute Grounds, near Belleville, Ontario.

16578—May 23—Approving agreement between Bell Telephone Co. and Algoma Steel Co., Ltd., Sault Ste. Marie, Ontario.

16579—May 22—Authorizing G.T.R. to use and operate jointly with C.P.R. spur to Toronto Furniture Co., Toronto, Ont.

16580—May 23—Authorizing C.P.R. to construct its second main line track across 5 highways on its Kenora, S.D., Man.

16581—May 23—Authorizing C.P.R. to construct spur to premises of Western Foundry & Machine Co., Ltd., Saskatoon, Sask.

16582—May 22—Authorizing Dominion Atlantic Ry. to construct its North Mountain Ry. Branch across highways between Centreville and Weston.

16583—May 23—Authorizing C.N.O. Ry. to construct bridge over Riviere des Milles Isles at mileage 37.9, from Hawkesbury, Ont.

16584—May 23—Authorizing C.N.O. Ry. to cross three highways in Township of Bristol, County of Pontiac, Que.

16585—May 9—Authorizing C.N.O. Ry. to connect its line with siding of Canada Cooperage Co. at Smith's Falls, temporarily.

16586—May 23—Approving revised location of C.N.O. Ry. in Twps. of Ross & Westmeath, Ct. Renfrew, mileage 69.15 to 71.08, from Ottawa.

16587—May 22—Authorizing C.N.O. Ry. to construct spur to premises of Shevlin Clarke Lumber Co., Ltd., Fort Frances, Ontario.

16588—May 23—Authorizing parish of St. Cuthbert, Ct. Berthier, Que., to construct highway across C.P.R., 2 miles east of St. Cuthbert.

16589—May 20—Approving location of G.T.P. Ry. through city of Fort William, Ont., in accordance with agreement between city and C.P.R., rescinding Order 8493, of Oct. 6th, 1909.

16590—May 27—Authorizing G.T.R. and C.P.R. to operate trains over interlocker at Nipissing Jct., without coming to a stop.

16591—May 27—Approving revised location of Toronto Eastern Ry. Co. through Twps. of Whitby and Whitby East, Ct. Ontario, Ontario.

16592—May 23—Authorizing G.T.P. to construct a (farm) crossing over C.P.R. near dock in city of Vancouver, B.C.

16593—May 27—Approving revised location of C.N.O. Ry. through Townships of Gibbons and Crerar, mileage 267.2 to 271.4, from Ottawa, in Nipissing District.

16594—May 27—Approving location of C.N.Q. Ry. through Counties of Two Mountains and Terrebonne, mileage 16.71 to 33.04, in Quebec.

16595-96—May 27—16597—May 23—Approving location of C.N.R. through Twps. 39-42, Rge. 1, west 3rd M., to 27 west 2 M., mileage 0.00 to 26.56, and location of C.N.R. (Alsask Southeasterly Line) through Twps. 25-26, Rges. 15-20, west 3rd M., mileage 42.59 to 85.24; authorizing C.N.R. (Strathcona-Camrose Branch) to cross C.P.R. Calgary-Edmonton Branch in N.W. ¼ of Sec. 16, Twp. 52, Rge. 24, west 4 M. Alberta interlocker to be installed.

16598—May 23—Authorizing Campbellford, Lake Ont. & Western Ry. to join its tracks with Ontario & Quebec Ry. (C.P.R.) at Glen Tay Ontario. (All C.P.R. roads).

16599—May 27—Approving revised location of Campbellford, Lake Ont. & Western Ry. (C.P.R.) at Glen Tay to mileage 2.08, miles.

16600—May 23—Authorizing C.P.R. to construct three additional tracks across Wolever Avenue and public lane in city of Winnipeg, Manitoba.

16601—May 27—Approving revised location of C.P.R. from mileage 0, at Bassano, for a distance of 35.38 miles, in 3-25-22 west 4 M.

16602—May 23—Authorizing C.P.R. to take certain lands of Toronto Belt Line Co., in connection with diversions of St. Clair Avenue and Scarlett Road, Toronto, Ont.

16603—May 27—Refusing application of Bell Telephone Company re crossing of Brock Ave. tracks of C.P.R. and G.T.R., Toronto.

16604—May 27—Authorizing C.N.O. Ry. to cross public road on Lot 21, R. 2, in Twp. of Clarendon, Ct. Pontiac, Que.

16605—May 28—Authorizing Alberta Central Ry. (C.P.R.) to divert trail at Rocky Mountain House, Alberta, by means of overhead bridge.

16606—May 28—Authorizing Esquimalt & Nanaimo Ry. to construct bridge No. 4.5 near Victoria, B.C.

16607—May 27—Refusing application of Campbellford, Lake Ont. & Western Ry. for crossing of G.T.R. at mile 70.74 from Glen Tay, Ont.

16608-09—May 27—Authorizing C.P.R. to construct spurs for Wm. Bannerman Co. ballast pit at mileage 2, Ignace S.D., Ont., and ballast pit spur for Ernest Hogg, near Agassiz, B.C.

16610—May 28—Authorizing C.N.O. Ry. to temporarily cross Con. Road in Twp. Georgina, Ont., by agreement with Twp.

16611—May 28—Authorizing C.P.R. to join its tracks with G.T.R. take certain lands necessary and to divert lanes, etc., near Clarence Square, Toronto, for freight purposes in connection with enlarging freight terminals.

16612—May 27—Extending until July 1st, 1912, time for completion of branch line authorized by Order 15542, November 22, 1911, C.P.R. (Credit Valley Ry.).

16613—May 28—Further extending until December 1st, 1912, C.R.C., No. 5, Telegraph Tolls of C.P.R.

16614-15-16-17—May 28—Authorizing C.P.R. to construct two branch lines for Henry S. Green, Parish of Kildonan, near Winnipeg, Man.; for Canada Sand-Lime Pressed Brick Co., Symes Road, Toronto, Ont.; for British Columbia Brass, Ltd., New Westminster, B.C.; for Argenteuil Granite Co., Ltd., Township of Chatham, Ct. Argenteuil, Que.

16618—May 27—Authorizing G.T.P. and Midland Ry. Co. of Canada to operate their trains over interlocker at Parish Lot 55, St. Boniface, Man., without stopping.

16619-20-21-22-23-24—May 28—Extending until December 1st, 1912, tariffs of tolls of G.N.W., G.T.P., C.N.R., White Pass & Yukon, North American, and Bell Telephone, Telegraph and Telephone Companies authorized by former Orders or Acts, 7-8 Edward VII., Chapter 61.

16625—May 29—Extending until July 1st, 1912, time for completion of fencing by G.N.R. directed by Order 16131.

16626—May 23—Directing C.N.R. to install an improved type of electric bell at Bay Bridge Road, Belleville, Ont.

16627—May 28—Authorizing V. V. & E. Ry. to construct dock and warehouse at Burrard Inlet, B.C. Rescinding Order 15093 of Oct. 16, 1911.

16628—May 29—Approving revised location of C.N.O. Ry. through Twp. of Clarendon, Ct. Pontiac, Que., mileage 55 to 58 from Ottawa.

16629—May 29—Authorizing C.N.R. to divert public road on its Swift Current Extension, Saskatchewan.

16630-31-32—May 30—Approving plans for bridge No. 61.51 on Woodstock, S.D., C.P.R., and authorizing C.P.R. to reconstruct bridge 58.59 on Cartier S.D., and bridge 57.1 on Cascade Subdivision.

16633—May 29—Authorizing G.T.R. to reconstruct bridge carrying public highway in Twp. of Caradoc, 18 District, Middle Division, County of Middlesex, Ont.

16634-35-36—May 30—Refusing application of city of Hamilton to cross with extension of Lottridge Street, the T.H. & B. Ry., Hamilton Radial Ry., and G.T.R.

16637—May 29—Relieving G.N.R. from erecting and maintaining fences from International Boundary to Bunclody, and from Bunclody to Brandon, Man.

16638—May 29—Authorizing Essex Terminal and M.C.R. to operate trains over crossing at Windsor, Ont., without stopping.

16639—May 29—Extending until July 1st, 1912, time for installing of derails by G.T.R. under Order 16411, April 19, 1912.

16640—May 28—Authorizing city of Lethbridge to construct across C.P.R. at 13th Street crossing for one year watchman or watchmen to be employed by city.

16641—May 29—Extending until 31st August, 1912, time for completion of work required by Order 15770, Jan. 11, 1912, diversion of highway and crossing of C.P.R.

16642—May 29—Authorizing G.T.R. to construct additional track across Bedford Street, Brantford, Ontario.

16643—May 30—Authorizing Quebec Railway, Light, Heat & Power Co. to construct siding into premises of Beaupre Sand Co., Ste. Anne de B., Que.

16644—May 29—Authorizing Michigan Central Railroad Co. to construct siding into premises of Dominion Canners, Ltd., in town of Niagara-on-the-Lake, Ontario.

16645—May 29—Approving location of V.V. & E. Ry. (G.N.R.) station grounds at White Rock, Province of British Columbia.

16646—May 23—Authorizing C.N.O. Ry. to connect its lines and tracks with C.P.R. at Meadowsite, Dist. of Nipissing, Ont., for a period of 5 months for construction purposes only.

16647—May 30—Approving location of C.P.R. Kerrobert Northeasterly Branch from mileage 20 to 36.08, Saskatchewan.

Volume 22. Toronto, June 20, 1912

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The Canadian Engineer

An Engineering Weekly

TIMISKAMING DAM CONSTRUCTION.

The second annual report of Mr. C. R. Coutlée, the engineer in charge of the construction of storage reservoirs on the Upper Ottawa River, has recently been published by the Department of Public Works. An abstract of the report dealing with the Timiskaming dam construction follows.

For several years prior to the commencement of the Georgian Bay ship canal survey in 1904, by the Department of Public Works, it was felt that something should be done to improve the conditions of low water on the Ottawa River. which made navigation difficult during the fall of low years, and crippled badly some of the power developments on the river. Representations were made to the Federal Government that the only possible remedy was to establish some system of storage reservoirs at the head waters of the Ottawa River, by which some of the surplus waters in the spring could be collected and conserved to be released gradually during the low period and thus augment the low flow.

crease the low water flow in time of deficiency, and that this control would not only be of benefit to navigation, but would be of great advantage to all commercial and industrial interests on the river depending on water for power and transportation.

Moreover the fact that large communities depend on an adequate and permanent river flow for the necessities of life, such as water supply for domestic purposes and fire protection, and the economical production of electrical energy for lighting tramways, industries, etc., gives to this control a national and vital importance. For these public utilities a shortage of water becomes a serious matter, as was exemplified in 1905 by the helpless condition of the powers at the Chaudière Falls on the Ottawa River on account of the long period of extremely low flow.

During the session of 1908-9, parliament voted the sum of $65,000 to commence the construction of storage dams

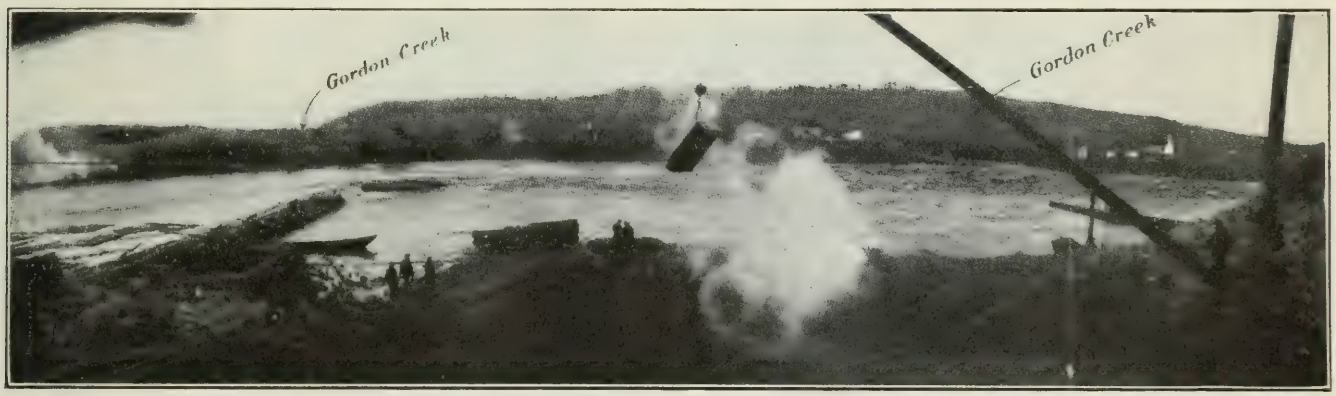


Fig. 1.—Timiskaming Dam, November, 1910. Coffer Dams, Quebec Channel, Stopped by Autumn Floods.

In 1904, Mr. George Brophy, superintending engineer, Ottawa River works, was commissioned by the Department of Public Works to carry on a preliminary investigation of the storage possibilities, the work having been recognized as of Federal importance. The result of his investigations is published in the report of the Georgian Bay ship canal, page 303.

During the extensive surveys made for the proposed Georgian Bay ship canal, and in elaborating a project for a first-class waterway, it was soon seen that no satisfactory scheme could be devised unless it included an efficient partial control by storage of the spring floods of the Ottawa River throughout its watershed, in order to reduce the fluctuations in the different reaches, to eliminate swift and dangerous currents, and to establish practically slack water navigation.

In the report on that waterway, it was shown that conditions in the upper Ottawa River were favorable to a partial control of the surplus waters which could be used to in-

on the Ottawa valley, previously recommended by Mr. G. P. Brophy, superintendent of Ottawa River works. Another sum of $20,000 was voted to continue the preliminary studies already commenced of the Ottawa River watershed.

Having been promoted to the position of Assistant Deputy Minister in the department, Mr. C. R. Coutlée, C.E., was appointed engineer in charge of the whole storage work, under the direction of the chief engineer, it being understood, however, that the work would be continued under my general supervision in an advisory capacity.

The report presented, after a brief review of the preliminary works performed in relation to storage during the survey for the canal, treats of the present waterpower development on the Ottawa River, the different lakes along its course, the characteristics of its watershed, its flow, etc., and gives figures as to the possible amount of water which can be stored in the natural reservoirs which it has been possible, so far, to investigate and study with a fair degree of accuracy.

It shows that storage so far in sight, and for which controlling dams are either under construction or sites fully surveyed and contract plans under way are:—

Basin.	Area. sq. miles.	Maximum Possible Depth. feet.	Storage. sq. miles feet.
Lake Timiskaming	100	20	2,000
Lake Kipawa	100	20	2,000
Lake Quinze and Expanse.....	100	20	2,000
Total			6,000

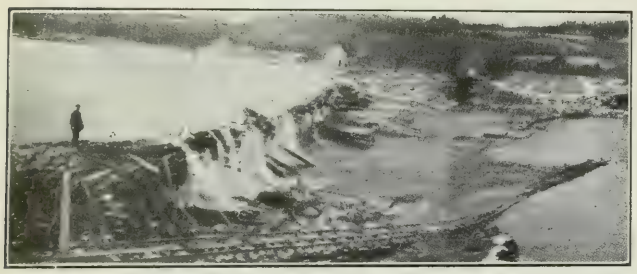


Fig. 2.—Timiskaming Cofferdam, Quebec Channel, 3rd May (Day Before Failure), Lake Surface Elevation 580.50. The Pit was Flooded from Below by Gordon Creek Water Several Days Before.

This represents a maximum possible reserve for each of these lakes of practically 56 billions cubic feet, or a total of 168 billions cubic feet of water, which instead of rushing to waste, would be pent up in these reservoirs and gradually let out during the low period.

Taking the low period at 150 days between October and March, it will then be possible to augment ultimately the low water flow at Ottawa for that period by 10,000 to 12,000 cubic feet per second. It can be seen, therefore, what immense benefits will be derived from these reservoirs. Their beneficial effect is admirably resumed in Mr. Coutlée's report, as follows:—

1st. They will improve the potability of the water.

2nd. They will increase the depth for navigation.

3rd. They will increase and steady the flow for power production.

These reservoirs, though large, would not, however, be sufficient to exert the full control that is required of the flood waters during the extreme years of flood flow, and further reserves may be had by other dams at the outlet of Lakes Turnback, Opasatika, Grand Lake Victoria, Birch, Barrière, Kakabonga and several other lakes on the main stream or on the tributaries, which are now under study, or will be investigated as soon as time and staff are available.

In relation to the reserve dams, the one at the foot of Lake Temiskaming and that on Kipawa River are under contract.

The progress of the work on the Timiskaming dam has not been as rapid as was desired and expected on account of heavy work in foundation. The Kipawa River dam is progressing satisfactorily. Both dams are of concrete with stop-log sluiceways, having an aggregate clear discharge sectional area at least as large as the original section of the river.

At the commencement of the fiscal year, $41,760 had been expended on the Timiskaming dam construction and a year's time. As stated in the last annual report, no adequate plant or force was employed on the contract at the commencement, so the summer of 1909 was lost. It was January, 1910, before a steam excavator began work, and February before concrete laying commenced.

The cold of this northern section created difficulties in excavating and concreting that had only been overcome when Timiskaming Lake, responding to a very early spring, flooded the foundations.

When driven from the base platform, however, the force was turned upon the island abutment, which was brought up to full height in May, 1910.

During June, new coffer dams were built across the Ontario channel and the section between pumped out by the 25th. This steam shovel resumed excavation and operated during July and August, but stopped for good during the first week of September with work still to finish. In May, two meetings with the contractors were held to discuss programs for hastening the work.

A couple more conferences were held in June, the hardness of the excavation and the unforseen difficulties of unwatering being discussed. With an active manager, a good scheme and better rate of progress were achieved during July and August, 1910; but this, the third, manager leaving at the end of July, the work became disorganized in a month. The time for completing the contract was extended from 22nd July to end of December, 1910.

Concrete.—When the foundation pit was pumped dry, 25th June, 1910, the concrete was found in good condition, although laid during the winter and flooded before the sun could hasten its set.

By the first week of July, forms were erected to half height for seven piers and concreting was resumed on the platform and aprons. A good speed was attained, and during August the most work was done, although the firm changed their manager on the first of the month.

In September, the concrete work on the Ontario sluiceways was finished and no more has since been done.

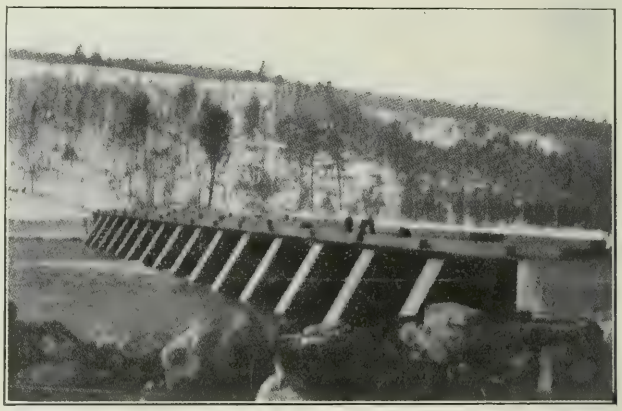


Fig. 3.—Timiskaming Dam. Ontario Sluiceways from Below, Showing Water on Lower Apron and Stop-Logs Piled on Roadway.

The piers and abutments are very fine samples of mass concrete work, the finish is good and the alignment particularly accurate.

The history of the concrete building in the Ontario sluiceways, during an unusually cold winter, is interesting.

Work began 12th February, 1910, and continued till April. Gravel of fair quality, but sandy, was the only available material and the mixing was done by machine. Large boulders were used as displacers in the concrete, each being thoroughly steamed to clean off ice before laying. The gravel and sand were stored in a bin that was heated by steam pipes and the water was also warmed. After laying, a movable steam radiator was set in place, and the mass covered with tarpaulins, so that all night the temperature was kept above freezing. The trench, into which the mixture, averaging 70° Fahrenheit, was placed, had, unfor-

tunately, hard frozen sides and there must have been a loss of heat to the frozen ground.

After being flooded with water at 32° F. for 70 days till 25th June, when the water was 55° F., the concrete was still soft enough to penetrate easily with a steel bar or pick. In 30 days, however, the mass was hard enough to resist repeated blows of a pick and only a few inches of the surface required to be removed.

The following gives an idea of the weather during one cold period in February, 1910:—

Record of Temperature.

1910	Day		Night	
	Maximum	Minimum	Maximum	Minimum
February 5	0°	-16°	-10°	-23°
" 6	-13°	-16°	-10°	-26°
" 7	19°	-10°	12°	26°
" 8	32°	26°	28°	- 3°
" 9	5°	- 3°	2°	-18°
" 10	- 3°	-18°	- 8°	-30°
" 11	17°	-24°	6°	2°
" 12	18°	4°	12°	-14°
" 13	21°	-10°	20°	13°
" 14	31°	17°	18°	-18°
" 15	1°	-14°	2°	- 7°
" 16	9°	0°	2°	-22°

The chemical and physical action of setting is illustrated by the following temperature records of concrete built by the Department of Public Works at St. Andrews dam, north of Winnipeg in 1907.

A pipe with closed bottom and a screw top was placed low in the concrete, a thermometer being suspended inside from the screw top. As the wall or structure came up, additional lengths of pipe were added. For the sake of comparison the results in the accompanying table are given for three different parts of the work showing considerable range of condition of laying. In this table (A) is the pivot pier of lock, a heavy mass of concrete 35 ft. high and built in summer, during August, 1907; (B) is submerged dam, Span No. 1, winter work, January, 1908, working 11 hours a day, and (C) is submerged dam, Span No. 4, winter work, January, 1909, working night and day.

Table Showing Varying Temperatures of Setting Concrete.
(Fahrenheit Degrees Above Zero.)

(A) Pivot Pier, built Aug. 1907			(B) Span 1 of Dam, winterwork, 11-hour day.			(C) Span 4 of Dam, winterwork, working night and day.		
Date 1907	Temperatures		Date 1908	Temperatures		Date 1909	Temperatures	
	In pipes	In Air		In pipes	In Air		In pipes	In Air
Aug. 28	Pipe set	65	Jan. 18	Pipe set	50	Jan. 20	Pipe set	53
Aug. 29	82.5	64	" 19	65	50	" 21	72	53
	84	69	" 20	75	50	" 22	80	.....
	86.5	64	" 21	77	.....	" 22	83	.....
Aug. 30	82.5	68	" 24	76	.....	" 23	86	.....
	86	76	" 27	78	.....	" 23	87	.....
	91.5	66	Feb. 5	78	.....	" 24	88	.....
Aug. 31	96	74	" 8	78	.....	" 24	110	.....
	98	77	" 9	76	.....	" 25	111	.....
Sept. 2	99	60	" 10	76	.....	" 26	110	.....
" 3	104	64	" 12	75	.....	" 26	110	.....
" 9	103	.....	" 18	70	.....	" 27	108	.....
" 11	103	.....	" 22	65	.....	" 30	80	.....
" 12	105	.....	" 26	65	.....	Feb. 2	80	.....
" 19	110	.....	" 29	63	.....	" 3	80	.....
Oct. 11	102	.....	Mar. 2	62	.....			
Nov. 5	82	.....	" 4	61	.....			
1908								
Aug. 16	49	65	" 6	60	.....			
" 29	51	.....	" 9	57	.....			
Sept. 25	52	43	" 13	54	.....			
			" 17	50	.....			
			" 24	45	.....			
			" 31	42	.....			
			April 3	42	.....			
			" 6	40	.....			
			" 8	39	.....			
			" 9	38	.....			
			Reading stopped by flood. Aug. 16 Pipes 62; Air 65; Water 67.					

No doubt, the Timiskaming concrete rose in temperature at some stage in setting.

For winter work, a new practice is to use very quick setting cement that hardens before it is cooled below chemical action temperatures. Work of this kind was done on the power plant near St. Timothee, Que., during this same cold winter of 1910. By mistake, a car of the quick setting cement, made at the International Works, Hull, Que., came to Timiskaming. Its hardening was so rapid that its surface could scarcely be smoothed over. The first batches being especially troublesome, because nothing of the kind was expected. The result was apparently as good concrete as any laid, however.

Designs of Sluiceways.—Plans and views of these sluiceways are shown in Fig. 5. The sill platform is at elevation 570, or 19 feet below standard level of reservoir. It would have been preferable to have the sill 5 feet lower, but the excavation necessary to cut down the approach channel would have doubled the cost.

Between the island and Ontario shore, the width was about 400 feet, so the design was made for 16 sluiceways each 20 feet wide with a pier 5 feet wide between. The piers have recesses to hold a movable curtain wall formed of horizontal timbers, 18 inches square, that can be hoisted out one by one. This is a removable dam and during spring floods all the timbers will be lifted out, leaving a larger exit than under natural conditions, because the Ontario channel has been deepened. To draw off the lower layer of storage during March, however, requires deeper sluice openings, and so advantage of the depth in the deep Quebec Channel was taken to place those sills at elevation 565, or 5 feet lower.

Minimum Discharge at Timiskaming Sluices.—The minimum through Timiskaming should be about 20,000 c.f.s. and lake surface must be 573.95 to discharge the total amount as shown by the following calculation made by H. H. Donnelly, assistant engineer:

Taking 572.1 as elevation of water below Timiskaming dam for a discharge of 20,000 c.f.s., then:—	
16 Ontario sluices, each discharging with 0.95 feet head and 2 feet submergence at the rate of 20.5 c.f.s. per foot of crest, total 16 x 20.5 x 20	6,560 c.f.s.
13 Quebec sluices, each discharging with 0.95 feet head and submergence at the rate of 52.5 c.f.s. per foot of crest; total 13 x 52.5 x 20	13,650 c.f.s.
	20,210 c.f.s.
If the Ontario sills were as low as the Quebec side, then, with Timiskaming lake surface elevation 573.05 and the surface below dam elevation 572.1, the discharge would be:—	
16 Ontario sluices, each discharging with 0.95 feet head, and 7 feet submergence at rate of 35 c.f.s., total	11,200 c.f.s.
13 Quebec sluices, each discharging with 0.95 feet head, and 7 feet submergence at rate of 35 c.f.s., total	9,100 c.f.s.
	20,300 c.f.s.

As designed, the lake surface can only be drawn down to elevation 573.95, instead of elevation 573.05, so a layer 0.9 feet thick is rendered unavailable.

As before stated, however, lowering the Ontario channel would double the cost which is not warranted at present.

Foundations.—The foundation of the sluices is shown in Fig. 5. It consists of a concrete platform, 3 feet thick, strong enough to support a pier, if undermined during a flood, till repairs could be made. To prevent under scour,

a cut-off is made 10 feet deep across the upper face and another 5 feet deep across the lower side. In addition, a concrete apron, 25 feet wide, protects the bottom from scouring under the driving water at entry, and a 50 foot wide apron below prevents wearing away of material by the rapidly leaving flow.

The Ontario bed is boulder strewn with hard material beneath, but the work done in the Quebec channel, before the cofferdam failed (May, 1911), indicates a sand, hard, but easily saturated. Through this material, the seepage

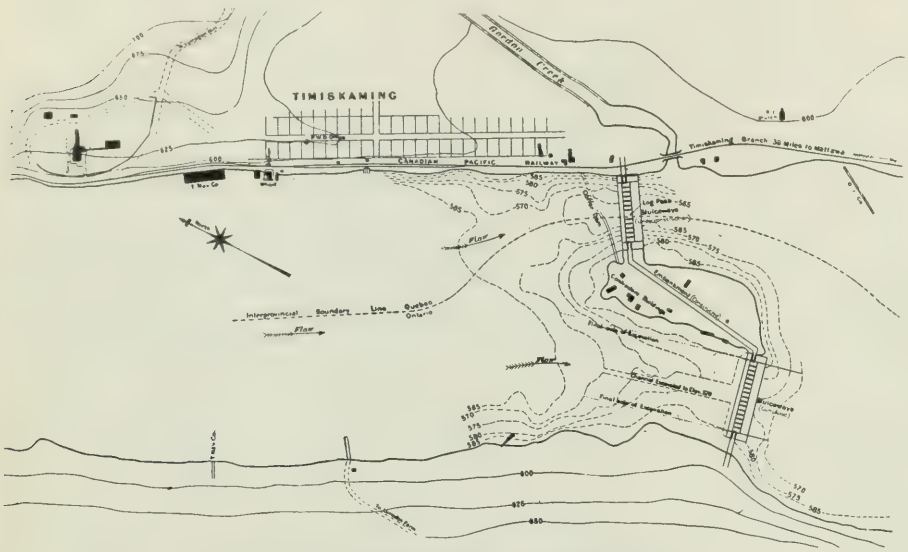


Fig. 4.—Plan Showing Timiskaming Regulation Works.

was all that four large pumps could conveniently manage. The foundation for the Quebec side will consequently be modified and include sheet piling beneath the cut-off wall. In fact, it proved impracticable to excavate the cut-off trench 10 feet deep in the sand, although the boring pipes were broken in piercing the undisturbed bed.

The depth to which a cut-off should extend in sand is debatable, but accepted practice is to go as far below the bed as the water surface is above.

Head water will soak the foundation, but cannot move the sand so long as it is boxed in or held by friction. If head water penetrates beneath the dam, then it buoys up the sand below and the tail water carries it away so rapidly that a cellar is formed.

Cofferdam, Quebec Channel.—After the middle of September, 1910, practically all the work was in connection with the cofferdam across the Quebec channel.

The type decided upon by the contractors was stone filled cribwork sunk to place and sheeted along the upstream face with plank. Round timber was procured from the Hawkesbury and Edwards limits near the work, and by the 17th October, the dam was half way across (210 feet). It was intended to unwater only half the channel and about 30 feet of cribwork was built down stream, but heavy rains caused an unusual rise of 5 feet and work had to cease. This brought most of the work on the dam to a stand-still, but sand was hauled and stone crushed which still remain stored upon the ground. The cable way was moved to the Quebec channel and put in working order by the middle of November, thus obviating the use of scows to cross material to the island. With a view to laying concrete during cold weather, arrangements were made to build a shed, 400 long and 60 wide, enclosing all the piers. Lumber was delivered for this, but owing to delays with unwatering, the shed could not be erected

To ensure immediate excavation of the foundation, orders were given to bring the steam shovel across the island. This machine had been left in the water since the Ontario cofferdam was cut in November.

Excavation continued in the island abutment, but leakage from the river through the fine sand stopped work several times, although a sheet pile bulk head was built, and a steam pump installed. Slips constantly occurred from the sides of the pit till finally, on 20th November, the river side burst in, when the excavation was to grade and only the cut-off trenches remained to be dug.

Lake Timiskaming continued extraordinarily high for the season, although the Kipawa River flow was shut flow was shut off by the Department's dam at that place. On 18th November, the Ontario cofferdam was blown out and the lake surface began to fall 2 inches per day. This had not been opened before, because the contractors were tendering for the excavation in the channel. The current soon scoured out between the south end of the dredge cut and the north end of the contractors' work passing a good flow through the sluiceways for the first time.

It was January, 1911, before the cofferdam was put under way again, when it was raised about two feet and track laid on top to carry stone filling and other material.

The lake had by then lowered three feet, so with a falling river, it was decided to cofferdam the whole channel and cribwork was begun from the Quebec shore. The advantage is that this method allows the foundation slab and cut-off walls to be built without joint. With a cofferdam half way across, the part parallel to the current requires to be a double crib with clay in the middle. Otherwise, the current will scour away staunching material from the exposed face, and in this case a boulder bottom prevents the driving of sheet piles.

An inexperienced force, cold windy weather, and the swift current made crib setting very slow and several cribs were lost by upsetting or breaking away of tackle.

By the first week of February, the new cribwork was connected to that built in October, and by the middle of the

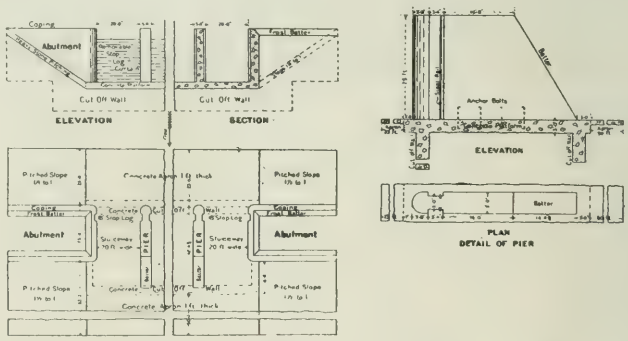


Fig. 5.—General Drawings of Concrete Sluiceways.

month the upstream face was sheeted with two thicknesses of boards. Large boulders upon the river bed made it difficult to closely fit the cofferdam to the bottom and cribs sometimes came to rest with one corner tilted over. No trench was dug in the river bottom into which to bury the ends of the face plank, because a diver could not work in the strong current. Instead, a bank was deposited along the front of the cofferdam, but the only earth available was fine sand that made a slurry in water.

The counterdam, across the lower end of the foundation area, to defend the pit from the lower pool, was finished by the end of February. There were only two small steam pumps, a six-inch and four-inch, on the contract and these could not lower the water below the lower pool, down to which it had run off naturally. Two large steam pumps, a twelve-inch and a fourteen-inch with boilers, were then rented and a pocket dam built just below the main dam. This was to intercept and collect the leakage which was led in box flumes over the work and emptied below the counterdam. The pocket dam was first a small earth bank, the sandy soil alone available, however, dissolved beneath the water, but froze hard in the air, bridging and obscuring leaky places. A sloping dam of planks, pointed and driven like sheet piling, was made but still the leakage kept the pumps fully engaged and water constantly burst beneath. Two more large pumps were added during March and every effort made to staunch leaks. It was not till the end of the month that four large pumps, working day and night, could keep the pit unwatered.

Meanwhile the spring rise was approaching, and to meet it the main cofferdam was raised 7 feet with continuous cribwork, which was filled with stone, adding weight to that already built. The cofferdam was of light section, but was well strutted on the down stream side. It was a question, whether stop-logs should be provided in this upper portion, but to arrange for them was difficult, and they could only pass 4,000 c.f.s., 5% of the flood. It seemed better instead, to blast out the Ontario side and increase by loosening and scour the space through which to get discharge, while the cofferdam blocked the Quebec channel.

The enlargement of the Ontario side by blasting and scouring was quite successful and aided the discharge greatly

Excavation in the Quebec foundation was possible during the last week of March and continued till the end of April. The lower pool then rose over the counterdam and operations had to cease, the plant being nearly all removed. On 4th May, the main dam failed by scouring under the Quebec end. The water was then overtopping it more than a foot.

Ontario Channel Excavation.—The dredge Queen excavated in the channel during the autumn of 1909 and encountered much difficulty from boulders upon which the scows and tug frequently grounded. After work stopped for winter, a force of drillers was kept on to blast boulders over the ground to be dredged during 1910. Low water aided this, and half the approach channel had been well prepared for dredging and some excavation had been swung out with the derrick by the end of March, 1910.

It was 17th May, 1910, before the dredge started, and after making one cut the dipper arm broke 18th June, then teeth were removed, so before repairs were finished it was 5th July. The material was so hard that it had to be blasted at times and low water prevented through cuts being finished to the contractors' work. The autumn rise, however, aided matters and a cut was fortunately carried to the cofferdam before work stopped in the middle of November.

The blasting of surface boulders was continued all season by a small force with good results, and when the cofferdam was cut 18th November, a good opening quickly scoured to the already excavated sluiceway channel.

Item	Unit	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
B. C. Fir 12" x 12"	C. ft.						1,200		8,600	11,650				21,450 c. ft.
White Pine 3" x 12"	Ft. b.m.								21,600					21,600 ft. B.M.
Steel Beams	Lb				11,800	30,900	2,500		33,900					79,100 pounds
Anchor Bolts	"	1,000			5,000	1,000								7,000 pounds
Common Excavation	C. yd			500	6,000	5,450		550	370					12,870 c. yds.
Rock Excavation	C. yd.			150	650	50	1,050	250	250	240				2,640 "
Boulder Excavation	"			60	540	300	700	300	180	220				2,300 "
Stone Protection	C. yd.				200		1,000	800						2,000 "
Concrete	C. yd.	600	250		1,150	2,660	320	4						4,984 "
Material on hand														
I Beams, Channels	Lb									100,500				100,500 pounds
Cement	Barrel									640				640 barrels
Sand	Cu. yd									2,400				2,400 c. yds.
Broken stone	"									4,200				4,200 "

Quantity of Contract Work in 1910-1911 on the Timiskaming Dam.

Item	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Total
B. C. Fir 12" x 12"						$ 768		$ 5,504	$ 7,456				$ 13,728
" 6" x 12"													
White Pine 3" x 12								918					918
Steel Beams				$ 708	$ 1,854	150		2,034					4,746
Anchor Bolts	$ 60			300	60								420
Common Excavation			$ 150	1,800	1,635		$ 165	111					3,861
Rock Excavation			225	975	75	1,575	375	375	360				3,960
Boulder Excavation			45	405	225	525	225	135	165				1,725
Stone Protection				150		750	600						1,500
Concrete	5,100	2,125		9,775	22,610	2,720	34						42,364
	$ 5,160	$ 2,125	$ 420	$14,113	$26,459	$ 6,488	$ 1,399	$ 9,077	$ 7,981				$ 73,222
Material on Hand.													
I Beams Channels									$ 3,015				3,015
Cement									640				640
Sand									1,200				1,200
Broken Stone									3,150				3,150
													$ 81,227

Value of Contract Work in 1910-1911 on the Timiskaming Dam.

During March, 1911, a force was placed blasting the material along the edge of the Ontario channel. The loosening allowed the current to scour the material and a large amount was quickly removed, increasing the flow way against the rising lake which was troubling Haileybury and New Liskeard.

Dredging.—The Department dredge "Queen" resumed work in channel on May 15th, 1910, and was taken off for the winter November 15th. The total excavation during this time was 6,150 cub. yds. scow measure. The dredge is too light for the work and has been in service for eight years, consequently, there were many breaks, and time taken for repairs was usually large. The total length of time on the work was 1,557 hours, viz.:—

Actual working time	870 hours	55.9%
Lost time, repairs, etc.	592 hours	38.0%
Lost time Saturdays cleaning up and fueling	95 hours	6.1%
	1,557 hours	

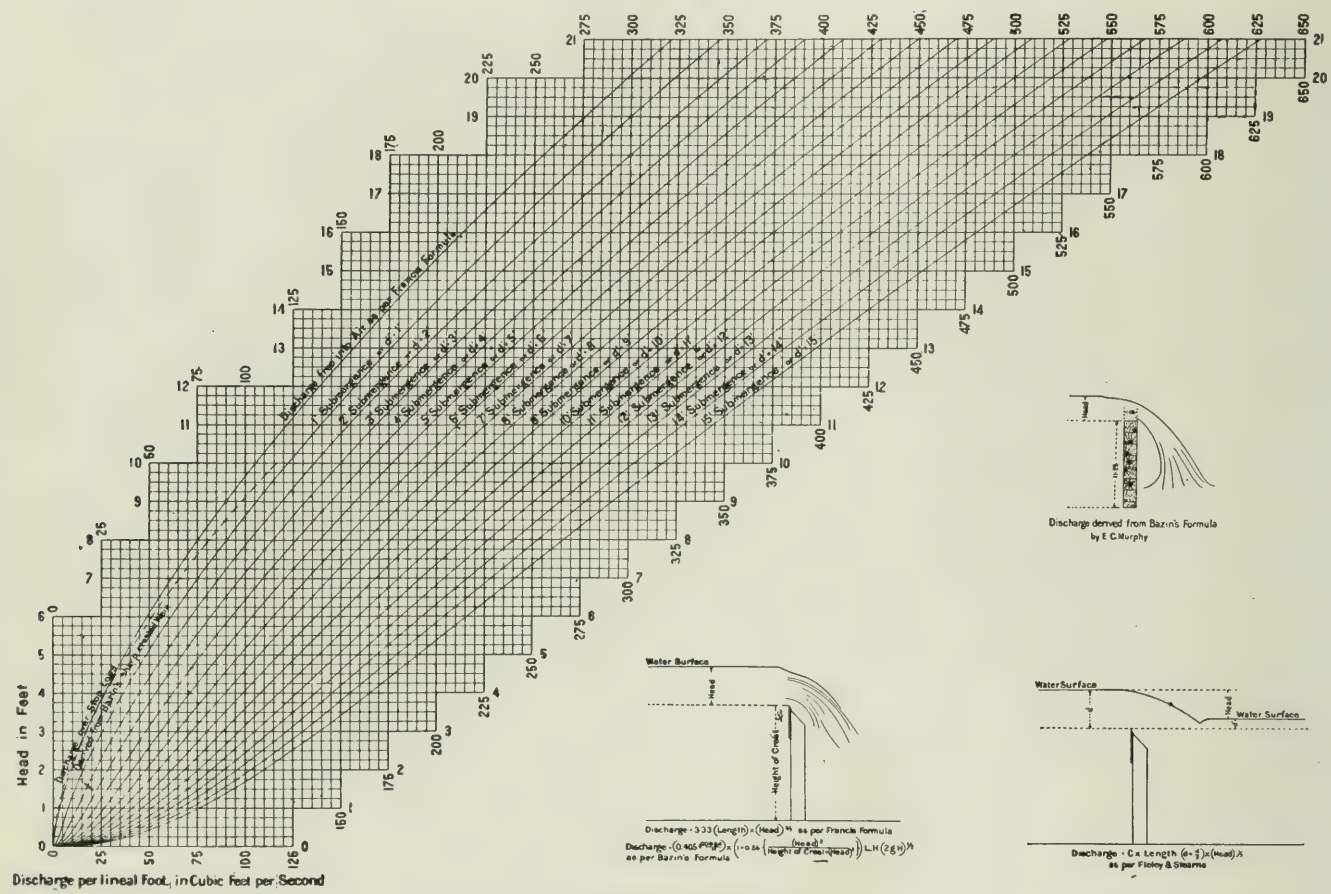
To open a channel through to the shovel cut excavated by the contractors, some work was performed lifting boulders. The dredge was also obliged to work in shallow water, where scows could not be used, and the excavation was taken away with a hand derrick. The extra labor cannot rightly be charged to drilling. The accompanying table shows the quantities and cost.

Summary of Cost of Drilling.

From October 6th, 1909, to November 30th, 1910.

Wages	$14,297	
Plant and accounts	6,863	$21,160
Less		
Clearing boulders to open channel	$840	
Taking away excavation from dredge to open channel, not chargeable to drilling	372	1,212
Net amount expended on drilling		$19,948

Area of channel drilled and blasted was 22,280 sq. yds., costing per sq. yd. of surface 89½ cents.


Head in Feet
Discharge per lineal Foot, in Cubic Feet per Second
Discharge derived from Bazin's Formula by E.C.Murphy
Water Surface
Head
Height of Crest
Discharge = 3.33 (Length) × (Head)^3/2 as per Francis Formula
Water Surface
Head
Water Surface
Discharge = C × Length (6 + 3/4 H) × (Head)^3/2 as per Fteley & Stearns

The Flow Over Weirs.

(From Report on Ottawa River Storage, Issued by the Department of Public Works, Canada).

The area of channel dredged in season 1909 was 583 sq. yds. During season of 1910 the area was 1,734 sq. yds., making a total area of 2,317 sq. yds.

Profiting by high water in November, 1910, the dredge was able to excavate close to the Ontario cofferdam, and when it was opened the water cut through between the contractors' shovel cut and the dredged channel.

Drilling and Blasting.—On March 1st, 1910, the area drilled and blasted was 7,700 sq. yds., since then 22,530 sq. yds., making a total to November 30th of 30,230 sq. yds.

Two No. 42 Little Giant steam drills were used for drilling on shore. Submerged work was drilled by hand from floats.

Area dredged, season of 1910, 1,734 sq. yds., which, at 89½ cents, cost for drilling $1,551.55.

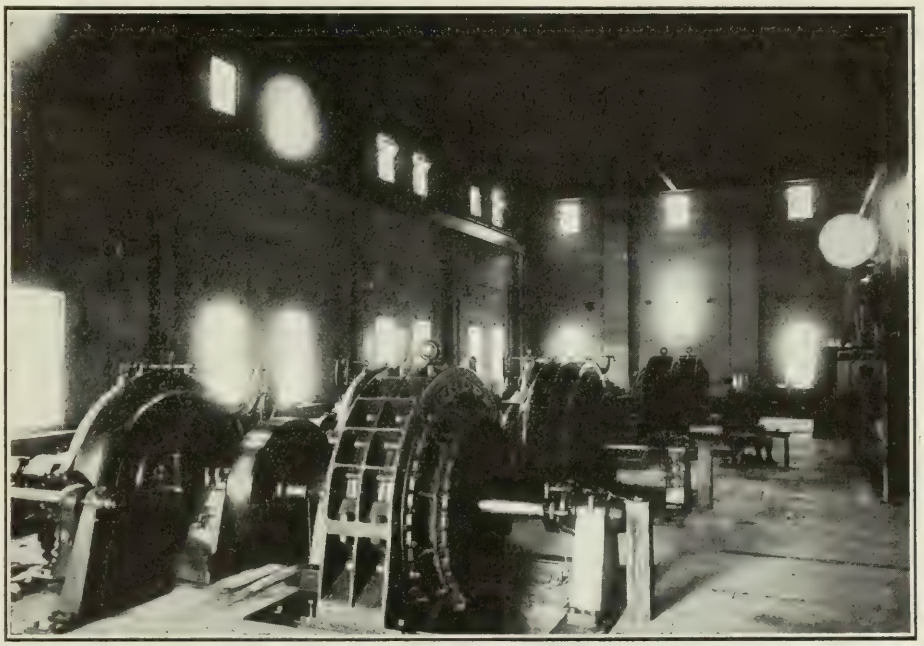
Dredged during season of 1910	6,156 c. yds.	
Cost of drilling per c. yd.	$0.175	
Cost of dredging per c. yd. (dredge $5 per hour.)	$1.268	
Cost of excavation	$1.443	per c. yd.
Cost of drilling operations, including removing boulders from channel, etc.	$0.187	
Cost of dredging	1.268	per c. yd.
Cost of excavation	$1.455	

POWER DEVELOPMENT IN COBALT.

By C. C. Bateman.*

In 1904, the rich silver mines of the Cobalt district were discovered, and while at first, believing that the deposits were not extensive, development was on a very limited scale, the camp gradually grew in size and importance, until it now occupies third place among the silver-producing communities of the world, the output being exceeded only by Mexico and the United States. During the year 1911 the output was approximately 33,000,000 ounces, and the production for 1912 will probably be about the same. The camp embraces an area of approximately seven square miles, in which there are thirty shipping mines, besides several non-shippers, and fourteen concentrators.

The running of mining machinery for comparatively small plants, as most of those in Cobalt were, does not readily lend itself to economical operation. The distance of Cobalt from the coal-producing centres is great, and as it is an all-rail haul, the cost of coal at the mines is necessarily high, averaging between $6 and $6.50 per ton. As a consequence, coal generated power is costly. A series of tests, carried on at the different mines over a considerable period, established the average cost for the camp at between 150 and $175 per horse-power year.



Interior of Concrete Power House on Matabitchouan River, showing four 1875 K.V.A. Generators, each being direct-connected to a 2,750 h.p. Turbine.

Within a comparatively short distance of Cobalt there were several good water powers, and when it was seen that the camp was firmly established as an important producer of silver, and that there was no question as to its permanence, companies were formed for the development and distribution of this power on a large scale. Considering the small area and the large number of consumers, the district lent itself very readily to this scheme.

Among these companies was the Mines Power, Limited, now known as the British Canadian Power Company, formed by E. A. Wallberg and F. John Bell, of Montreal, which secured a valuable water power on the Matabitchouan River, about twenty-two miles distant from Cobalt. Permission was also given by the Government to dam several of the lakes above the falls, thus providing for a large storage capacity, and eliminating as far as possible, the danger of a water shortage.

The main power dam is 50 feet high at its deepest point and 860 feet long. It raises the water about 40 feet above its former level, and gives a working head of 312 feet. It is estimated that a total of 10,000 horse-power can be developed if necessary.

By means of an intake canal the water is diverted to two steel penstocks, each five feet in diameter, and 1,075 feet long. Two turbines are supplied from each penstock. These turbines are of the horizontal reaction type, consisting of a single runner in a spiral case. They have a speed of 600 R.P.M., and are rated at 2,750 B.H.P. each. The power house is a solid concrete fireproof structure, 57 x 105 feet, and is fitted with all the latest appliances. It is also equipped with a travelling crane for handling the heavy machinery.

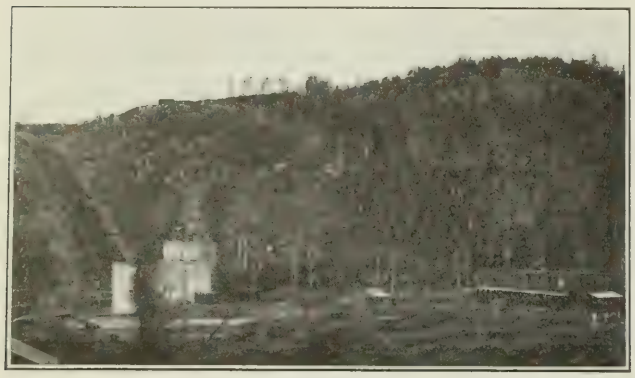
The electrical equipment consists of four alternating current generators, directly connected to the turbines, and having a capacity of 1,875 kw. each. There are two exciters, each directly connected to a Doble impulse water-wheel. These are rated at 180 horse-power, 475 R.P.M. High-power governors have been installed to ensure perfect regulation. The current is three-phase, 60-cycle, and is generated at a pressure of 2,200 volts. For transmission to the power stations at Cobalt and South Lorraine this potential is raised to 44,000 volts by means of step-up transformers.

There are two separate three-phase transmission lines, 35 feet apart, over a right-of-way 135 feet wide. The right-of-way has been entirely cleared, and, to further minimize danger of breakage, all tall trees on each side of the line have been cut down. The conductors are stranded aluminium cables, and the poles are equipped with high-tension porcelain insulators, which were subjected to the most severe tests before being used. The conductors on each pole line are of sufficient capacity to carry the whole load, thus eliminating the danger of a shut-down due to a break in the line. The whole system has, in fact, as far as was possible, been constructed in duplicate. The main transmission line is equipped with a private telephone system, and patrolmen are stationed at intervals.

For the distribution of this power to the various mines three brick and concrete substations have been erected. Two of these are at Cobalt; one at Cobalt Lake having a capacity of 5,500 horse-power, and one at Brady Lake having a capacity of 3,200 horse-power. The third station is at South Lorraine for supplying the mines of that vicinity. Each substation is equipped with all the necessary step-down transformers, lightning arresters, switching devices, etc. The electrical current is delivered to the customer at 2,200 volts, and by means of pole transformers is reduced to 550 volts for motor service, and 110 polts for lighting. Power is sold to the consumer on a flat rate of $50 per

* Mine engineer, The Dome Mines Company, Limited, South Porcupine, Ont.

horse-power year, or on a meter basis, with prices varying for the class of service and the amount consumed. While this rate is high in comparison with the rates for similar service in industrial centres, it is eminently fair, considering the high cost of such an undertaking and the shorter life that must be looked for in a mining district.



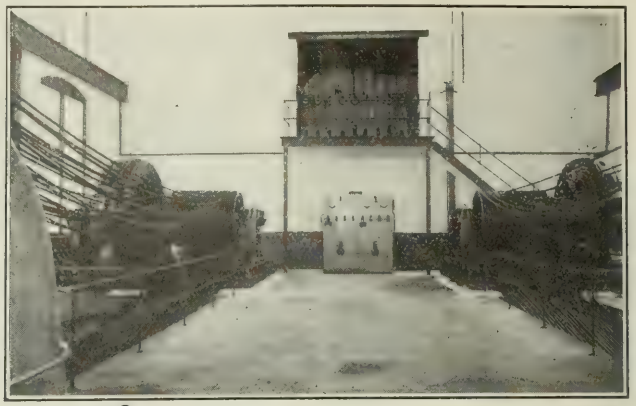
General View of Concrete Power House, Operators' Houses, Penstock Covering, Tail-race and Double Pole Lines to Cobalt.

An interesting feature of this company's power development is its system for supplying compressed air to the various mines. At both the Cobalt Lake and Brady Lake substations are identical compressor plants, each consisting of two two-stage air compressors. Each machine has a capacity of 5,000 cubic feet of free air per minute, and is driven by a 1,000 horse-power motor. This gives a total capacity of 20,000 cubic feet of free air. The compressors are equipped with the regular intercoolers, and each substation has installed an extra large water after-cooling system. From this the air passes through a large separator, and then through an air-cooling system. On account of the high temperature in the summer this latter system is only in use during the winter months.

Main Concrete Dam, 50 feet high, on Matabitchouan River, showing Timber Log Slide.

The air is delivered through steel pipes, with diameters varying from three inches to ten inches, and the two substations are connected by a ten-inch main. All the pipes are lapwelded, and the larger sizes come in 40-foot lengths. They are fitted with wrought-iron forged flanges, welded on, and each pipe has a weld in the cross section, made by the oxyacetylene process. They have all been tested to a pressure of 300 pounds per square inch. All fittings, valves, etc., are made of steel, and the pipes have all been coated on the inside with "Doctor Smith's Solution."

When the construction of these pipe lines was first under consideration, the question of expansion joints was taken up, but it was finally decided not to install them as



Two 1,000 horse-power Motors driving Compressors at Cobalt Station.

they were not considered sufficiently reliable. During a period of twelve months the extremes of temperature may amount to as much as 150 degrees Fahrenheit, and, in order to take care of the excessive expansion and contraction, the pipe lines were zig-zagged, and, although the plant has been in operation over two years, no trouble has yet been experienced.

There is at times in the pipe line a small accumulation of water, and, while this is not sufficient to affect the mines, it gave trouble by freezing in the winter time and stopping up the pipes. This difficulty was overcome by the application of an electric heater, the design of Mr. James Ruddick the former general superintendent of the company. At the lowest points of the pipes a ¾-inch cock is placed, so that the water will drain both ways to it. This cock is left slightly open all the time, and during the winter it is

View showing Ten-inch Pipe Line, with Electric Heater, 2,200 Volt Electric Pole Line, and 44,000 Volt Double Transmission Line, in Cobalt Camp.

kept warm and prevented from freezing by the use of the electrical heater. Automatic traps are being installed to take care of the accumulation of water in the warm weather

The air is delivered to the mines at 100 pounds pressure, and practically atmospheric temperature. The company endeavored to get high-pressure air meters, with the intention of selling the air at 24 cents per thousand cubic

feet of air compressed to 100 pounds pressure. These were found impracticable, however, and the air is now sold on the basis of $2 per drill per shift.

Two 1,000 horse-power Two-stage Air Compressors at Cobalt Station.

Operations in this plant were started in the first part of June, 1909, and power was first turned on March 17th, 1910, which is an enviable record for an undertaking of this size, considering the difficulties to be overcome.

As an evidence of the manner in which water development in Cobalt has succeeded in cutting down the consumption of coal, it may be stated that in 1909 the coal used in Cobalt amounted to 105,416 tons, while in 1910 and 1911 the consumption was 52,861 and 44,216 tons, respectively. Steam boiler plants are still in use for heating purposes, and the majority of hoists are still run by steam, so that a considerable quantity of coal is still brought into the camp.

AN ELECTRICALLY OPERATED LABOR-SAVING DEVICE IN LUMBER MILL.

The use of electrically operated machines in wood working plants has been the means of effecting many economies in their operation, so that it is not surprising to hear frequently of some new application of an electric motor in this industry.

The application illustrated and described herewith has proved to be so much more efficient in operation than the method it superseded that a description of it may prove of interest.

The apparatus consists of an automatic hydraulically operated door veneering machine installed in the plant of the Commercial Sash, Door and Blind Co., Beaver Falls, Penna.

This plant is most completely equipped throughout with individual electric motor drive, a total of 24 motors being used. Some are mounted on the ceiling and others on the floor in places most convenient for driving their respective machines. Those mounted on the floor are placed in enclosures to protect them from the dust and dirt such as is usually prevalent in plants of this kind. The veneer is placed on the door frames and when a sufficient number are ready they are placed in the compress as indicated in the illustration, which shows 110 1⅜ inch frames piled in five rows. Two sets of I-Beams are put in place one above and one below the frames, and turn-buckle clamps attached from one set to the other are tightened so as to hold the frame intact. After this has been done, the motor, mounted on the ceiling just above the compress, is started and the operator opens the valve which allows the hydraulic pressure to act. Gradually the carriage rises, compressing the frames until the pressure, as indicated by the gauge at the side of the machine, has reached the desired value. This value is usually from 1,300 to 1,600 pounds per square inch, depending on the nature of the wood to be compressed. A pneumatic safety valve automatically opens at any predetermined value, thus preventing any possibility of danger from excessive pressure.

It will be noted, on referring to the illustration, that the bottom portion of the compress is in the form of a truck. By means of this construction the material may be loaded directly on the truck which is then rolled to the compress on car tracks. When the desired pressure has been applied for a few minutes (about two, generally), the valve is opened; the pressure gradually relieved, and the truck returns to the normal position and is then rolled away.

As an example of the economy effected by this veneering machine, it should be noted that the time required for compressing is only about two minutes, while that required by the old hand-operated method was from four to five hours. With this method, the frames can be removed at once after they have been compressed, although it is generally customary to leave the clamps on for an hour or so, whereas in the older method it was necessary to have them on for several hours.

Automatic Hydraulically Operated Door-Veneering Machine.

The plant is equipped throughout with Westinghouse induction motors, taking current from the central station lines.

LUMBER PRODUCTION.

Two-fifths of the lumber of Canada is produced in Ontario, one-fifth in British Columbia, and one-fifth in Quebec; New Brunswick and Nova Scotia together make up the greater part of the remaining fifth, and but proportionately small quantities are manufactured in Saskatchewan, Manitoba, Alberta and Prince Edward Island.

THE COLLAPSE OF THE NEILSON BUILDING.

While an addition of three stories was being made to the Wm. Neilson Company's two-story chocolate factory on Gladstone Ave., Toronto, the south wall collapsed. Work commenced on the 28th March and the accident occurred on the 4th of May, when the wall was almost finished and part of the roof on.

As the plans show, the building was 90 ft. x 120 ft., and consisted of a basement and five stories. Mill construction was the type adopted for this building, and the rows of posts running east and west were spaced 14 feet apart; joists or floor beams, 5-in. x 12-in., 4 ft. on centres, spanned the 14 ft carrying three inch spruce flooring. This flooring was ploughed and a hardwood slip-tongue or spline used, and was securely blind-nailed to the Georgia pine joist. Duplex joist hangers were used throughout, and steel anchors every eight feet were fastened to the underfloor, i.e., over every other joist. Thus the beams ran east and west, the joists north and south, and the spruce underfloor east and west. The

View of Building After Collapse of Wall.

main beams were tied together with steel straps and the ends secured to the walls by wall boxes. From north to south during construction the tie consisted of the friction between the joists and hangers at the beam, and the rigidity of the floor platform, while the hardwood floor would complete the tie. The parapet wall of the old building (14-in. thick), was removed and the new wall started on top of the wall of the second story (18-in. thick). The new brick work, like the old, consisted of hard burnt clay facing brick, sand-lime lining brick with soft or salmon fillers laid up in lime mortar.

The old building was erected with the intention of adding two stories at some later date, and in order to satisfy to the city by-law, as part of a four-story building, the basement wall was made 22-in thick, and the first and second stories 18-in. thick. For the same reason the walls of the first story were designed to allow 30 per cent. of openings, while those of the second gave 40 per cent. Application was made, however, to the City Architect for a permit to erect the five-story building which was granted on condition that certain windows were to be blocked up to make the proper percentage of openings in the lower stories, and the first story wall was left 4-in. thinner than the City by-law requires.

In order that the Neilson Company might continue their business in the first and second stories, (in the old portion) the contractors agreed to arrange their work so as not to enter these stories and to hoist all of their material over the south wall.

For this work the bricklayers erected a double elevator hoist the full height of the intended structure, a couple of feet south from the street, staying it with guys. This hoist was operated by a small steam engine, and was so arranged that as a load went up on one platform the empty wheelbarrow came down on the other. This proved as it always does, to be a very efficient method of carrying the bricks and mortar. The carpenter had a gin wheel, with the fall passed through a snatch block made fast to a niggerhead, and a horse was then able to lift all the smaller material, including the 3-in. spruce flooring. For the heavier timbers there was a breast derrick mounted over the girder, nearest the south wall, with a 30-ft. boom which projected beyond the wall and as the timbers were swung over the floor they were lowered on trucks and wheeled to the required positions.

In order to permit of this hoisting the bricklayers left a section (some 30 or 35 feet long) of the south wall towards the western end open until the rest of the walls for that story was finished when they would fill this in. The carpenters would lay the new floor, raise the gin wheel and derrick to the new level and proceed as before. At the time of the accident the most of the roof and parapet wall was on, but this gap in the south wall on the top story was not filled.

The inquest was conducted by Mr. J. E. Elliott, who spent considerable time and took endless pains to make the investigation thorough, and the profession is indebted to the coroner and Crown Attorney Greer, for their efficiency in this matter.

It is a pleasure to see men in their positions anxious to get at the truth and at the same time sufficiently patient to listen to all.

The list of witnesses is a long one and may be classified as follows:

1. The medical experts.
2. Eye witnesses who were outside of the old portion of the building.
3. Eye witnesses who were inside of the old portion.
4. The contractors.
5. The architect of the building.
6. The city architect and staff.
7. Expert witnesses.

The medical expert testimony our readers are not particularly interested in, so that we will begin with the second class, viz., eye witnesses outside of the old building.

Of these examined was John Sole, who was the engineer in charge of the bricklayers' hoisting engine. He was at his post at the engine a few feet south of the centre of the south wall facing west and said that about 10.30, he heard a noise as of wood tearing and on looking up he saw some bricks falling about 30 feet behind the boiler. He fixes the position of the first failure very definitely as east of him i.e., the eastern part of the wall and towards the top. Several of his answers are very definite and full of information—"Gradually opened at the top and collapsed right straight down"—"The whole tearing was on the east side and it fell down and collapsed in a heap." "Did not fall out whatsoever, simply opened and collapsed."

Q. "How long did the whole break take from the time you first saw it until the finish?" A. "About a minute—it fell very slowly for a wall." Q. "Were the bricks thrown far to the south?" A. "No, I think about 30 or 35 feet." Q. "Your engine did not explode?" A. "Oh no, did not explode whatsoever." As this was the only boiler in addition to

that supplying the factory with power and heat and which is still in good condition, in the immediate neighborhood of the building, it settles the theory proposed by the Assistant City Architect, that the accident may have been due to a boiler explosion.

Chas, Watman, a foreman for the Bell Telephone Company, who was working about 300 feet south of the building and had almost an unobstructed view of the fatal wall said, "I heard the noise and then I thought, silence and I could not hear anything. I thought it was inside, something falling; just sounded like as though it was a big timber or some lot of bricks had fallen." Q. "Perhaps what you heard was the first few bricks Mr. Sole speaks of." A. "Might be—very great noise." "I think they hit some boards if I am not mistaken." He was too far away, however, to observe any of the details other than those already mentioned.

Robert Harion, a street railway conductor, was walking south on Gladstone Avenue, and said that a few moments before the accident they were using the derrick. He saw the boom projecting over the wall. This agrees with the evidence of the carpenters, that they were dismantling the derrick and at the time of the accident had the boom lying on the fifth floor projecting slightly beyond the face of the wall.

Jas. Foley, bricklayers' laborer, was wheeling material north on the fifth floor when he heard a noise, looked around and saw the wall falling.

Wm. Palmer, carpenters' laborer, was standing on the fourth floor, three windows from the west end. Q. "First thing that called your attention was the noise?" A. "Yes." Q. "Could you see daylight?" A. "No, but I could see her open a little and she wobbled like that." Q. "So then Mr. Sole's impression of what happened is nearly correct, the east end fell completely and dragged the west end after it?" A. "Yes."

Albert Hamilton, a bricklayer working on the west wall, heard a noise, looked around and saw the south wall disappear from view going down straight.

These witnesses and others agree that their attention was first arrested by a noise of considerable magnitude. That the first failure was in the upper part of the eastern end of the new wall, that it buckled and fell vertically. It might be added here that the coping was found near the base of the wall.

The only evidence our readers are interested in as given by those witnesses who were inside the old building at the time of the accident, may be summed up in the statement that they all heard a great noise, looked up and saw bricks coming through the ceiling and ran.

The evidence of the contractors, i.e., brick-work and carpenter-work went to show, that they had entered into the agreement for certain consideration to supply material and labor as called for in certain plans and specifications and so far as they were concerned they believed they had lived up to their contract to the satisfaction of the architect, the City Architect and Mr. Neilson. They could not account for the accident, but Mr. Wood said that he would never build a brick wall, using lime mortar, as fast again. They did not consider the vibration from the machinery in the building, nor that from the three hoists of any serious consequence.

The architect of the building explained the plans, and the method of working as already indicated, and further said that this factory was of ordinary and not mill construction.

In order to make it clear to our readers, it would be well to mention here that the by-law defines ordinary mill construction, slow burning, fireproof, etc., and according to their definitions, the Neilson building was not mill construction, because, first of all, the joists were not of 60 sq. in. sectional area; second, the roof boarding was under 2¾-in.; third, wooden corbels were used; fourth, there were a number of wooden partitions less than 2¾-in. in thickness. These, and a few other minor details certainly bear out the architect's classification.

The transverse tie of the building from wall to wall (north to south) was criticised by some of the witnesses and commented on by the press at some length.

In his evidence the architect explained that during construction the tie was as follows:—

Every joist (40 ft. on c.) rested on a duplex wall hanger which had a lug ¾-in. high, so that the joist would have a tie equal to the straining resistance of 3 x 5 sq. inches of Georgia pine. The bearing plate of the hanger was 5 x 9 inches, so that this tie to the wall was at least fair. At every second joist a wall anchor was made fast to the top of the three-inch spruce floor, making fastening number two from the joist to the wall. The other end of the joist rested on a duplex hanger without a lug, so that the tie there was frictional only. The main tie, however, as he explained, consisted in the fact that the floor system in the first bay, 14-in. wide, formed a rigid platform of 5-in. x 12-in. joist to which was securely spiked three-inch spruce flooring in long lengths, and broken joists well fastened to the wall. He further pointed out that when the hardwood floor which would run north and south, was laid, it would complete the system of cross ties. When asked his opinion of the cause of the accident he said he could not tell. There were a number of causes such as vibration, handling material over this green wall, but none of them, nor all of them together, were sufficient, in his opinion, to cause the collapse. It was possible, however, that in handling some of the heavy timbers the wall had received a blow which would weaken it and finally cause the trouble. He said that he was well satisfied with the materials and workmanship of both contractors.

The City Architect in his evidence stated that he had issued the permit for the alteration, claiming that when the windows mentioned before were blocked up, the building would conform to the by-law. It would be well here to look at the reading of the by-law regarding the thickness of walls. Section 22, page 39 reads as follows: "The walls of all brick buildings shall not be built of less thickness than called for in the following tables." The table referring to this building gives the following thickness: basement, 22-in.; 1st floor, 22-in.; 2nd floor, 18-in.; 3rd floor, 18-in.; 4th floor, 14-in.; and 5th floor, 14-in. Sub-section 2, page 44, reads: "In the foregoing tables of thickness of walls the perpendicular distance from the top of joists in one story to the corresponding point in the next story is to be understood to mean not more than 12 feet in the basement or cellar, 19 feet for the first floor, 16 feet for the second story, and 15 feet for each for all stories above the second except the top story, which may have an additional 5 feet in height at the highest point. If any single story exceeds these respective heights the walls of such story and all the stories below the same shall be increased ½-inch, or about 4½ inches more than the thickness given in the tables."

Now, in his evidence the City Architect granted the permit knowing that the walls of the first story were only 18-in. and not 22-in., as required by the tables in the by-law, because the walls were old and well set and because the heights of the 1st, 2nd, and 3rd stories, when taken together, did not exceed the limit as set by the by-law. You have but to look at the wording of the by-law to see the very careless interpretation placed on it by the guardian of the public.

To him the collapse was a mystery because the materials used were excellent, the workmanship good, and the work regularly inspected, though not as frequently as he would have liked.

F. H. Sykes, of the Department, identified the plans and specifications of the building as those which he had pased through the office, and presented an elevation of the south wall, as it was just prior to the accident. The plan showed the windows that were to have been blocked up and gave a list of the loads per square foot on the various piers.

Mr. Tice, the inspector of the dictrict and Mr. Price, the Assistant City Architect, also gave evidence. Among other things, they said that the building rested on virgin soil and nor made land. That the foundation walls went down some 8 feet and were still in good condition. That the materials used were perfect, the workmanship was first class. To them, as to their chief, the cause of the failure was a mystery.

A most remarkable statement was made by the Assistant City Architect, viz., that the floor load which would be placed on the wall by the hangers which went 5-inches into the wall would be distributed uniformly through the wall by the bonding courses. That after some four or five courses this would not be an eccentric load.

The Expert Witnesses.—R. Marshall, a demonstrator at the School of Science, made a number of tests in the different materials used throughout the building and pronounced them all as good.

Mr. Newall, an experienced builder, examined the ground and pronounced it virgin soil. He also stated that he had plumbed the walls left standing and said that they were plumb and true and that the posts were also plumb.

Robert W. King, a civil engineer, stated that in his opinion the wind blew the south wall out, and that the tie was not strong enough to hold it. The report of the weather as obtained from the Meteorological office, shows that at the time of the accident and for several days previous to it the wind was only a gentle breeze from the east or south so that this theory must be dispensed with.

He also criticized the use of wooden corbels and even though they had nothing to do with the failure of the wall, the point is well taken and in our opinion the by-law section 45, page 97, should be amended so as to include other kinds of construction as well as mill.

The section reads, "If wooden posts are used in **mill construction** they shall have cast, wrought-iron or steel caps of an approved pattern, so constructed as to form a base for the next post above." Certainly the words "mill construction" should be dropped from this by-law.

Prof, C. H. C. Wright, of the University of Toronto, in his evidence stated that he believed the building rested on virgin soil, that the foundation walls were in good shape, that the failure did not start in the old walls and that therefore, the failure to block up the windows in the old wall as required by the department, had nothing to do with the failure. The theory had been advanced by some that the swelling of the 3-in. spruce floor had pushed the wall out. But as he said, this wood went in wet and would shrink rather than swell, and as the boards were nailed on one side, the only effect of shrinking would be to open up cracks between the boards. He claimed that as the openings in the north wall were similar to those in the south it was absurd to talk of the wind forcing a pocket and blowing the south wall out. He agreed with Mr. King that where a system of wooden posts and girders are used, wooden corbels should not be permitted. It was a system that was gradually being done away with and he felt that the city of Toronto might reasonably prohibit their use.

He said that the transverse tie of the wall was sufficient during construction and with the hardwood floor laid, satisfactory.

He said that he considered the vibration from the light machinery in the old building was negligable, but that was due to the handling of the materials over the south wall of the three systems would retard the setting of the mortar. He pointed out that the base of the smaller piers in the fourth story, as the weak spots in the wall. The windows are arranged in groups of three with two small piers between them, while those between the groups are larger. The measurement of the piers on the inside between the wooden sills is two feet, while on the outside it is three, and the offset occurs a half inch back from the face of the wall which is 13½-in. thick.

At this point he stopped to explain that the authorities were often misguided in reference to the strength of brickwork, and masonry. The failure to classify brickwork properly and to distinguish between the piers as built in the laboratory and those built commercially were the reasons for much of the trouble. In the laboratory every brick is selected, they are thoroughly wetted, laid frog up, with even joints of from ¼-in. to ⅜-in. thickness, joints perfectly filled, etc.

To make allowance for this difference, Kidder and other authorities place the **safe** loan on brickwork masonry of hard burned clay brick laid in lime mortar at from 5 to 7 tons per square foot.

The wall under consideration was built of hard burned brick for facing, a good sand lime brick for the inner surface, and a soft brick filler. The bricks on the inner side were smaller than those on the outside, and hence the joints on the inside were thicker than those on the outside. The inside of this wall was therefore, weaker than the outside. The bricks were laid frog down thus losing one-third of the bearing area of the brick. (It is only fair to say here that this is quite a common practice in Toronto).

In his opinion the safe load on this brickwork is five tons per sq. ft. when set. As these piers were only from two to three weeks old, he felt that the safe load on them was not over half the safe load when set.

The weight of the floor and roof without considering any load on either, gives a load of 1,000 lbs. acting 2½ inches in from the inner face of the smaller pier, while that due to the brickwork was 13,000 lbs. acting at the centre of the pier. This gives a stress of between 3.5 and 3.75 tons per sq. ft., which he considered to be beyond the safe stress in these green piers; and whenever a load beyond the safe limit is used a chance is taken. These piers were weaker on the inside than the outside and under this loading they buckled and fell.

Speed, then, was in his opinion, the main cause of the accident. When asked about the material used he said that the materials were all good and the workmanship quite satisfactory.

It might be added here that by insisting on a better classification (i.e., not permitting hard surface brick with soft cores to be classed as hard burned brick) and a more rigid inspection, many cities have raised the safe load for hard burned brickwork with lime mortar, to, from 8 to 9 tons per sq. ft.

In summing up the evidence for the jury the coroner gave a very fair review of the facts as brought out by the investigation. The finding of the jury will, we are sure, prove to be very satisfactory to the profession. It will be agreed that recommendations Nos. 3 and 4 are good, but that Nos. 1 and 2 are weak.

The following is the finding of the jury:—

"It is the opinion of this jury that the collapse of the south wall of the Neilson building was due to a combination of circumstances.

Causes:—

"(1) Vibration caused by the working of the gin wheel, bricklayers' hoist, derrick and machinery in the occupied portion of the building, retarding the setting of the mortar."

"(2) Strain caused by the hauling of all materials over south wall while in a green state."

"(3) The green wall had the load put upon it before the mortar had time to set."

"(4) The above combined with a possible cause set as a jar or shock which the wall may have received while in a green state."

Riders:—

"(1) We are further of the opinion that walls of this height and length should be built of pier construction."

"(2) That in the construction of a building of this type a temporary tie should be used while under construction."

"(3) That buildings of this dimension should be more frequently inspected."

"(4) We would also suggest that cement be used for rapid construction."

When Coroner J. E. Elliott read over the finding, one juror rose to dissent to clause 3 of the causes. He wished it recorded that he did not think the wall was over-loaded.

Prof. Wright made what we consider a wise recommendation when, in his evidence he said that he thought the city should insist on having the staircase in every such factory building enclosed with brick walls or some other substantial fireproof construction.

It would also appear that Section 14, page 38, of the by-law is not enforced. It reads as follows:—"No pier buttress or pilaster shall be built in freezing weather, and all brick in such piers shall be laid frog up and pushplaced or grouted at each course." As Prof. Wright says, why not have bricks always laid frog up and get the bricklayers into a good habit?

GOWANUS CANAL PUMPING PLANT.

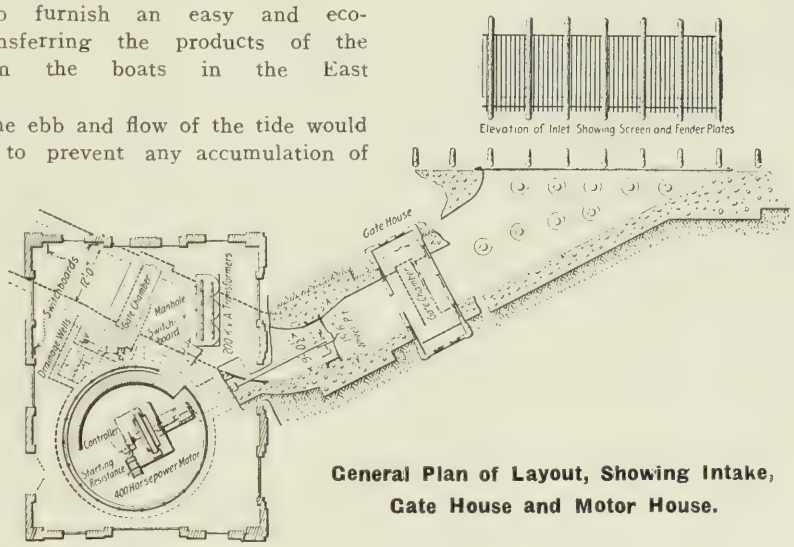
When the Gowanus Canal was constructed in Brooklyn a number of years ago it was heralded as one of the greatest engineering feats of the age.

But it was not long before the engineers were confronted with a serious problem which it has taken thirty years to solve; and only then through the aid of electricity.

The canal was built from the river, through a devious route to a point in the heart of the manufacturing portion of the city, and there dead-ended.

Its purpose was to furnish an easy and economical method of transferring the products of the shippers to and from the boats in the East River.

It was thought that the ebb and flow of the tide would cause enough circulation to prevent any accumulation of impurities which would be disagreeable or unhealthy. A large amount of surface water was drained from the streets and emptied into the canal through sewers, but due to increase of population and manufacturing industries, which are continually depositing waste matter in the canal, the water became most foul and unsanitary. It was also found that the action of the tide had little or no effect in removing the waste matter. This was especially true at the dead-end of the canal, where the stagnation was excessive. The odor was so foul that it could be detected for blocks around, and was so detrimental to the public health in that community that drastic measures were taken to effect more sanitary conditions.



General Plan of Layout, Showing Intake, Cate House and Motor House.

Finally, the city engineers decided on flushing the water from the dead-end of the canal into the river, where it would be carried away by the action of the tide. To accomplish this it was decided to install a screw propeller pump, which would simply pull the water along in the same manner that a propeller pulls a ship against the resistance of the water; in this case, however, the propeller being stationary, the water is forced to move. It was first proposed to employ steam to drive the pump, as had been done on one or two similar installations made in other places, but the engineers soon saw the advantages to be had by employing electric drive, and lost no time in convincing the city authorities of the advantages, and so an induction motor was selected.

The result was the removal of all the filth and polluted waters from the canal and a clean, healthy atmosphere now prevails. Property value in the immediate neighborhood which, under the old regime had sunk to almost nothing, has now increased to its proper value.

The motor and control apparatus are located in the circular pit 24 feet in diameter and 29 feet deep, built under the pump house.

The motor is rated at 400 h.p., and runs at 120 r.p.m. with full load, enabling the pump to deliver 30,000 cubic feet of water per minute. It is located 56½ feet from the propeller, to which it is connected by a shaft eight inches in diameter. The propeller consists of four blades having a pitch of 5 feet 6 inches, and the shaft runs through a water-cooled thrust bearing.

The tunnel is 12 feet deep and 50 feet wide at the canal but narrows down to 9 feet at the propeller, thus allowing ⅛ of an inch clearance for the propeller blades.

This water is discharged into what is known as Buttermilk Channel through a sewer 6,300 feet long. An interesting point in this connection is the fact that the water moved by the propeller weighs 64 pounds per cubic foot, or 2½ pounds per foot more than the weight of pure water.

Electric energy is delivered to the plant at 6,600 volts and is stepped down by means of three oil-cooled transformers at 550 volts, at which potential it is supplied to the motor through a suitable switchboard equipped with the necessary motors and control devices. The motor and control apparatus were furnished by the Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa.

GOVERNMENT DRYDOCK IN TORONTO

In our issue of July 27th, 1911, mention was made of a drydock that was to be constructed at the yards of the Polson Drydock and Shipbuilding Company. When it became known that the Federal Government would give financial aid to the project, Mr. Wm. Newman, works manager, visited

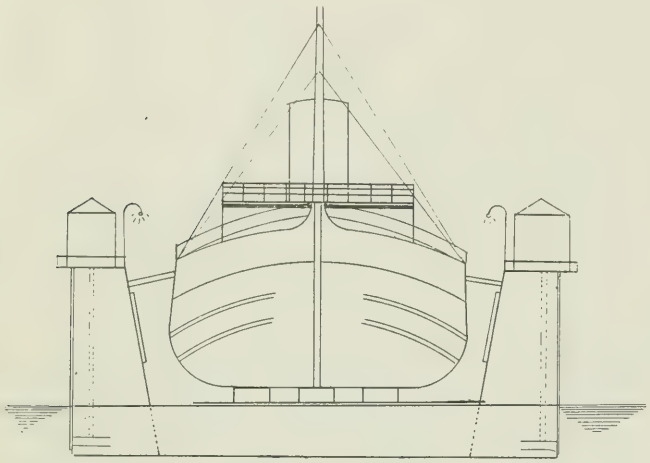


Fig. 1.—Section Through Drydock, Showing Vessel.

several drydocks in Europe and the United States with the result that the original plans and design were altered to a considerable extent.

The plan as originally laid out called for the construction of the dock in two sections, 150 × 100 feet each, and included arrangements so that the two docks could be merged into one resulting in a combination that would accommodate a ship of 4,500 tons and a beam of 80 feet. The new design calls for a structure 330'0" long: 100'0" wide: 35'4" deep: 72'0" wide on deck: 88'0" wide on top and 8'6" depth of hold: will weigh approximately 2,400 tons, with a lifting capacity of 5,400 tons, and will cost in the neighborhood of $392,000.00.

A reference to Fig. 2 will make the main details of construction clear.

The structure consists of one longitudinal watertight bulkhead amidships, and a transverse watertight bulkhead every 50 ft., dividing the dock into 12 equal compartments 50 ft. square, with a pump in each. All framing is transverse, 30 in. centres, and the plating is in excess of Lloyd's requirements. In addition to the longitudinal watertight bulkhead, there are six longitudinal lattice bulkheads, equally distributed, which, with the sides, insure absolute longitudinal rigidity. There is a transverse truss frame fitted every 10 ft. of ample proportions, which support the bilge block cross tracks. The bilge blocks will have a relieving screw under the top block, and will be of British Columbia fir which will have a certain amount of floating power and will be retained in position by underhung wheels enabling one man to operate them with ease.

There will be a joint in the centre of the dock composed of 6" x 6" x ½" angles riveted round the inside of shell, by means of which the sections are held together by 1¼" machine bolts every 6" with a rubber gasket between to make watertight. Butt straps 30" x ¾" are bolted all around dock at joint above light water mark. Rolling fenders are placed on the inside of dock at the ends to protect dock corners from boats entering and leaving.

Four ship's capstans are situated on the upper deck to handle ship's lines when docking. Another feature is the mooring device of the dock itself. An I-beam is riveted on the outside of the dock, perpendicularly, opposite each bulkhead, which are held in loose clips on the edge of the wharf allowing the dock to raise or lower, or list if necessary, without adjusting.

There will be compressed air, steam, and electric power conduit systems run on both sides of the dock, with manifolds every twenty feet for operating the tools. Sixteen arc lights are hung from the upper deck with plugs for drop lights every ten feet, which will permit of continuous work on the dock when necessary.

The only opening in the dock is a small hatch into each compartment from the upper deck, which, in case of accident, can be sealed and compressed air pumped in to expel the water.

One section of the dock can be used for docking the other section. This dock is large enough to take the largest and heaviest boat on Lake Ontario, which is the car ferry "Ontario No. 1"—317' 0", between perpendiculars, and 5,146 tons gross. The pumping equipment consists of twelve 12" centrifugal pumps with a capacity of 42,000 imperial gallons per minute, working in batteries of three in each quarter of the dock: each battery driven by a 75 h.p. D.C. motor, and all pumps being controlled from a central station ashore, which commands a view of the entire dock and is all handled by one man.

With this pumping equipment the dock may be emptied of water in twenty-four minutes. The equipment is entirely frostproof and is so designed that the absence of levers and piping is at once conspicuous.

There are twelve pumps, one in each section of the dock, which is divided by watertight bulkheads every fifty feet.

In order to get a site large enough to construct this dock, it was necessary for the Polson Drydock and Shipbuilding Co. to acquire the two water lots east of their present works, and they have been filling in all winter. The output of the yard will be in no way restricted as special plant has been procured from England to carry on the construction of this dock, which no doubt will fill a long-felt want in marine circles in the Port of Toronto. The structure will be located at the foot of Frederick Street.

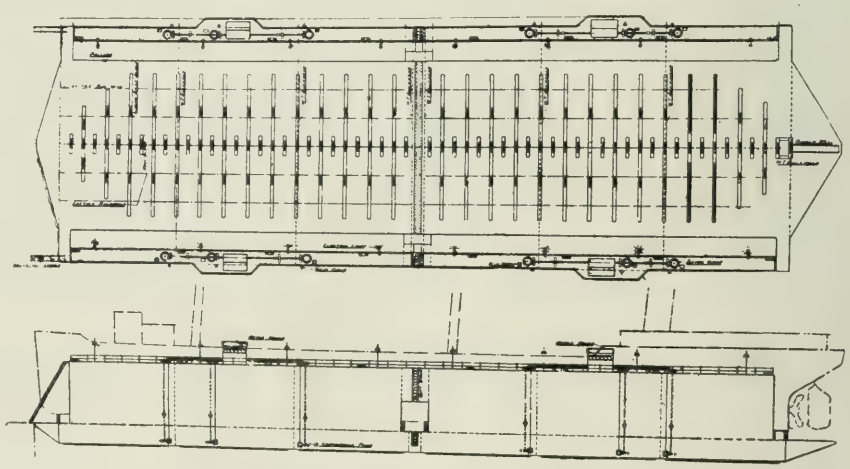


Fig. 2.—Plan and Elevation of Floating Drydock.

Sir Thomas Shaughnessy, of the Canadian Pacific Railway, has announced the intention of that company to double track their line through the Rocky Mountains, at a cost of $60,000,000.

STEAM TURBINE DEVELOPMENT.

The development of the steam turbine has been very rapid. Mr. A. G. Christie in a paper presented to the American Society of Mechanical Engineers recently, takes up the present state of development of large steam turbines. His view of the probable tendencies for the future are of interest and we present them almost in full.

Mr. Christie states that the cost of manufacture is a very important item in determining the future development of the steam turbine. Types such as the original Parsons and the Rateau, while inherently of very high efficiency, have too high manufacturing costs to compete with the newer combined types.

The writer offers as his opinion that the combined types, such as the Curtis-Parsons, the Curtis-Rateau, and also the Curtis-Rateau-Parsons, previously described, will very soon supersede the simple types. It is probable that the Curtis turbine will eventually be built only in horizontal units and will gradually be modified to a Rateau or even a drum impulse construction in the low-pressure sections. The freedom from close adjustment in impulse turbines and the recent improvements in blading materials will greatly increase the use of this type, although Curtis-Parsons turbines are said to be cheaper to manufacture. In actual operation, it is an open question among engineers whether the reaction turbine has a higher commercial efficiency than the impulse type, and hence buyers usually consider first cost and personal preference only.

Turbines will probably be made shorter with very stiff shafts. With this construction many of the earlier blading troubles will disappear. But the peripheral speeds will also be increased and this will involve the development of suitable blading material and methods of holding blades that will satisfy these new requirements. Recent results seem to indicate that improved efficiency may be looked for with increased blade speeds.

Several impulse turbines have been built recently in Europe where the expansion was not complete in the nozzle, so that a portion of the expansion took place in the first moving blades. Some large Curtis turbines recently installed in America are said to have Parsons blading in the last stage. These developments would indicate a movement to introduce reaction principles in impulse turbines, and further illustrate the tendency to merge types.

The hope of further improvement in efficiency lies in extensive study, particularly of the action of the steam during its passage through the moving and stationary blades, of the effect of form of blades, passages and casings and of various forms of baffles and balance pistons to prevent leakage. Such research work has not been carried out up to the present time by most manufacturers, largely on account of the extreme care and heavy expense involved in such tests. The present state of development has been largely one of cut and try. The increasing competition of the gas engine and the possible development of a satisfactory gas turbine will force manufacturers to develop their turbines to the greatest degree of economy.

With regard to detail, simplicity will be the leading consideration. With the introduction of Curtis high-pressure stages, nozzle governing will undoubtedly be used to an increasing extent, though the results obtained by Westinghouse, by Zoelly, and by Bergmann with simple throttling governors, raise a question as to whether the additional complication of nozzle governing will pay. Oil relays will probably replace all other systems of governing on account of their simplicity and reliability. The simple and efficient centrifugal oil pump governor of Sulzer appears to be an improvement of considerable moment, and will probably receive extensive use.

With the development of suitable gearing for steam turbines, their field of application has been greatly increased and turbines will shortly be used for purposes which engineers to-day would consider them utterly unfit.

Low-pressure turbines will continue to be installed in plants where reciprocating engines are still in operation and also where large quantities of waste heat are available. The low and mixed pressure types of turbines will find a very extended use in connection with heating systems, evaporators, etc.

The development of the past ten years has been truly marvellous. No great gain in thermal efficiency seems possible, so that future improvements will be largely along the line of detail construction and modification.

ADVANTAGES OF OIL AS FUEL.

In a recent discussion regarding the oil engine Mr. Wolcott Remington, the designer of the Blanchard Oil Engine, stated very clearly the advantages of oil as fuel. Mr. Remington stated that in general the cost of kerosene oils is approximately one-half the cost of gasolene, while the ordinary distillate and fuel oils may be obtained for about one-fourth of the cost of gasolene. He recommended that oil purchases be made direct from oil companies, as local retailers' prices are frequently twice as much as the former.

In the United States the total annual production of kerosene, fuel and distillate oils is about 6,500 millions of gallons, as against 720 millions of gallons of gasolene. Therefore it is fair to assume that the increasing use of internal combustion engines will not materially affect the cost of oils for a long time to come, since their production is so large and must continue to be so long as gasolene is used. On the other hand gasolene is continually increasing in price and becoming of inferior quality.

A most important advantage of kerosene and fuel oils over gasolene is their comparative safety. Kerosene is non-explosive and has a flash point of 150°F., or more. Gasolene, on the other hand, readily volatilizes at normal temperatures, and this vapor is not only very poisonous but is highly explosive when mixed with air. Insurance companies in many places permit the installation of oil engines where the use of gasolene engines is absolutely prohibited.

THE BEGINNINGS OF MONEL METAL.

About seven years ago one of the large smelting companies began investigating the chemical and physical properties of an alloy that had been reduced directly from nickel-copper matte without the previous separation of the two metals. This alloy was found to possess not only the valuable properties of nickel, but also other desirable properties in addition, that would insure a wide usefulness, and owing to the simple method of production, was obtainable at about one-third the cost of nickel. In 1905-6 the International Nickel Co. considering, no doubt, that for many purposes there was no need to separate the amicable metals nickel and copper, took up the problem of reducing them together and obtaining an alloy of the two metals in the proportions in which they occur in the ore. The alloy thus obtained was named Monel Metal, after Mr. Ambrose Monel, the president of the International Nickel Company.

Table for obtaining Weights of Pipes or Hollow Cylinders of any Substance.

By F. TISSINGTON.

NUMBER OF CUBIC INCHES IN ONE FOOT LENGTH.

Internal Dia.	Thickness of Substance								Internal Dia.	Thickness of Substance									
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2		3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4
1/8	.294	.883	1.767	2.94	4.41	6.18	8.24	10.60	2	15.48	21.12	27.24	33.6	40.20	47.16	54.36	61.80	69.6	77.7
1/8	.442	1.078	2.20	3.53	5.14	7.07	9.27	11.78	2 1/8	16.34	22.38	28.71	35.34	42.26	49.47	56.98	64.8	72.9	81.2
3/16	.589	1.472	2.65	4.12	5.89	7.95	10.30	12.96	2 1/4	17.16	23.52	30.12	37.08	44.28	51.84	59.64	67.68	76.2	84.8
1/4	.736	1.764	3.09	4.71	6.62	8.83	11.34	14.13	2 3/8	18.10	24.73	31.65	38.86	46.38	54.19	62.29	70.68	79.3	88.3
5/16	.883	2.061	3.53	5.30	7.36	9.72	12.36	15.32	2 1/2	18.96	25.92	33.12	40.68	48.48	56.52	64.92	73.56	82.5	91.8
3/8	1.032	2.352	3.97	5.89	8.10	10.59	13.4	16.49	2 5/8	19.88	27.09	34.6	42.42	50.52	58.92	67.59	76.56	85.8	95.4
7/16	1.178	2.65	4.41	6.48	8.83	11.48	14.43	17.67	2 3/4	20.76	28.00	36.12	44.16	52.56	61.20	70.20	79.44	90.2	98.8
1/2	1.320	2.94	4.86	7.06	9.57	12.36	15.48	18.84	2 7/8	21.64	29.46	37.56	45.96	54.63	63.62	72.9	82.47	92.3	102.5
9/16	1.472	3.24	5.30	7.65	10.30	13.25	16.48	20.02	3	22.56	30.60	39.00	47.64	56.64	65.88	75.48	85.32	95.5	105.9
5/8	1.620	3.52	5.73	8.24	11.05	14.16	17.52	21.12	3 1/8	23.41	31.81	40.5	49.48	58.76	68.34	78.20	88.36	98.8	109.6
11/16	1.767	3.83	6.18	8.82	11.78	15.02	18.55	22.38	3 1/4	24.3	32.98	41.97	51.25	60.82	70.69	80.85	91.3	102.1	113.1
3/4	1.908	4.12	6.62	9.42	12.48	15.96	19.56	23.52	3 3/8	25.17	34.16	43.44	53.01	62.88	73.04	83.49	94.3	105.3	116.6
13/16	2.06	4.41	7.06	10.01	13.25	16.78	20.61	24.73	3 1/2	26.06	35.34	44.91	54.78	64.94	75.39	86.16	97.2	108.4	120.1
7/8	2.20	4.71	7.51	10.47	13.92	17.64	21.6	25.92	3 5/8	26.95	36.48	46.32	56.52	66.96	77.76	88.8	100 08	111.7	123.6
15/16	2.35	5.00	7.95	11.19	14.72	18.55	22.6	27.09	3 3/4	27.84	37.70	47.86	58.32	69.12	80.16	91.44	102.96	114.9	127.2
1	2.50	5.30	8.38	11.76	15.36	19.44	23.64	28.20	3 7/8	28.71	38.88	49.32	60.12	71.16	82.44	94.08	105.9	118.2	130.8
1 1/16	2.64	5.59	8.83	12.36	16.20	20.32	24.74	29 41	4	29.60	40.08	50.88	61.92	73.20	84.8	96 72	108.9	121.5	134.4
1 1/8	2.79	5.88	9.27	12.96	16.92	21.24	25.75	30.60	4 1/8	30.48	41.28	52.32	63.6	75.24	87.12	99.36	111.9	124.7	137.8
1 3/16	2.94	6.18	9.72	13.54	17.65	22.08	26.76	31.80	4 1/4	31.44	42.48	53.76	65.4	77.28	89.52	102.1	114.8	128.0	141.3
1 1/4	3.09	6.48	10.15	14.16	18.36	22.92	27.84	33.00	4 3/8	32.28	43.56	55.2	67.08	79.32	91.92	104.6	117.8	131.1	144.8
1 5/16	3.24	6.76	10.59	14.72	19.14	23.82	28.86	34.16	4 1/2	33.12	44.76	56.64	68.88	81.48	94.2	107.4	120.7	134.4	148.4
1 3/8	3.38	7.08	11.05	15.36	19.80	24.72	30.0	35.40	4 5/8	33.96	45.84	58.08	70.68	83.4	96.0	109.9	123.6	136.8	151.9
1 7/16	3.53	7.36	11.48	15.9	20.58	25.62	30.92	36.99	4 3/4	34.8	47.04	59.64	72.36	85.56	98.88	112.5	126.6	140.8	155.5
1 1/2	3.67	7.68	11.88	16.44	21.36	26.52	31.92	37.68	4 7/8	35.76	48.36	61.08	74.28	87.60	101.2	115.3	129.6	144.2	159.0
1 5/16	3 82	7.95	12.37	17.05	22.09	27.39	32.96	38.88	5	36.72	49.44	62.64	75.96	89.64	103.6	117.9	132.6	147.3	162.6
1 5/8	3.97	8.16	12.84	17.64	22.8	28.32	34.00	40.08	5 1/4	38.52	51.84	65.52	79.56	93.8	108.4	123-2	138.4	153.9	169.6
1 11/16	4.12	8 54	13.22	18.26	23.56	29.64	35.02	41.23	5 1/2	40.2	54.2	68.5	83.16	97.9	113.1	128.6	144.3	160.4	176.7
1 3/4	4.27	8.77	13.68	18.84	24.24	30.0	36.0	42.36	5 3/4	42.0	56.64	71.4	86.64	102.1	117.8	133.9	150.2	166.9	183.8
1 13/16	4.32	9.09	14.04	19.44	25.44	30.84	37.08	43.56	6	43.68	58.92	74.4	90.12	106.2	122.5	139.2	156.1	173.2	190.8
1 7/8	4.56	9.42	14.58	20.04	25.80	31.80	38.16	44.76											

This table may be used for any substance having the form of a hollow cylinder. If the weight is desired, all that is necessary is to know the weight per cubic inch of the material and multiply the values given in the table for a particular diameter and thickness of material and the answer will be in pounds per foot run.

Below are given values for a few of the common materials usually met with in the form of tubes:

	Wt. cub. in.		Wt. cub. in.
Wrought Iron Solid Drawn Tubes	.283 lbs.	Glass	.107 lbs.
Do. Lap Welded	.270 ,,	Do. Common	.091 ,,
Do. Boiler Tubes	.277 ,,	Platinum	.778 ,,
Cast Iron	.263 ,,	Silver	.378 ,,
Steel	.282 ,,	Tin	.265 ,,
Copper, Cast	.314 ,,	Zinc	.260 ,,
Do. Sheet	.322 ,,	Lead	.410 ,,
Do. Seamless	.329 ,,	Do. Composition 7 Lead, 1 Tin	.382 ,,
Bronze Copper 8, Tin 1	.306 ,,	Do. do. 7 Lead, 1⅓ Tin	.373 ,,
Brass, Cast	.297 ,,	Do. do. 7 Lead, 2 Tin	.363 ,,
Do. Sheet	.303 ,,	Do. do. 7 Lead, 4 Tin	.340 ,,
Aluminium	.092 ,,	Do. do. 7 Lead, 8 Tin	.315 ,,
Do. Bronze Al. 10%	.278 ,,	Do. do. 7 Lead, 16 Tin	.300 ,,

The figures given above are intended to represent average values, and if very near results are required the weight per cubic inch of the material in question should be obtained specially.

The Canadian Engineer

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EXPERT TESTIMONY.

Very often the engineer is called upon to give expert testimony in cases before the courts, and oftentimes he is asked to prepare reports on the values of properties and damages to properties by public undertakings or improvements. In compiling these reports the subject must be looked at from every viewpoint, and the engineer must take the utmost care to maintain a fair and judicial attitude towards the claims of both parties. A prominent consulting engineer, in a recent address, states that it is quite easy to set up a theory of damages, and, assuming such a theory to be correct, to make figures which are favorable to the interests for which the expert is working, and this he considers proper, provided the engineer believes the theory to be correct and to meet the conditions fairly.

Recent expert medical testimony given in some of the recent criminal cases in the United States makes the public feel rather critical towards expert testimony in general. The engineer, in dealing with cases which require a judicial atitude, has a perfect right to work in the legitimate interests of his client, but he should also keep in mind the right of the opposing party. It is only by so doing that the engineering profession can be kept from falling into disrepute in connection with court cases.

CHEMICAL ANALYSIS OF CEMENT.

Much has been said recently with regard to the value of chemical analysis for the testing of Portland cement. Many chemists claim that the chemical analysis of a cement will indicate its quality better than a standard physical test. An engineer stated in the hearing of the writer a few days ago that in his opinion the chemical analysis method had not received the recognition for testing purposes that it deserved, and he inferred that the reason for this was the natural conservatism of the engineer with regard to a new idea. The United States Bureau of Standards has just issued Bulletin No. 33, covering the United States Government specifications for Portland cement, including specifications, standard method of testing, methods of chemical analysis, investigation of results and auxiliary specifications. The opinions there expressed leave little doubt as to the opinion of the Bureau of Standards concerning the chemical analysis method for determining the quality of cement. A normal Portland cement which meets the standard specifications for soundness, setting time, and tensile strength has an approximate composition within the following limits:—

	Per cent.
Silica	19.0 to 25.0
Alumina	5.0 to 9.0
Iron oxide	2.0 to 4.0
Lime	60.0 to 64.0
Magnesia	1.0 to 4.0
Sulphur trioxide	1.0 to 1.75
Loss on ignition	0.5 to 3.00
Insoluble residue	0.1 to 1.00

It is also true that a number of cements have been made both here and abroad which have passed all standard physical tests in which these limits have been exceeded in one or more particulars, and it is equally true that a sound and satisfactory cement does not necessarily result from the above composition. It is probable that further investigation will give a clearer under-

standing of the constitution of Portland cement, but at present chemical analysis furnishes but little indication of the quality of the material.

Defective cement usually results from imperfect manufacture, not from faulty composition. Cement made from very finely ground material, thoroughly mixed and properly burned, may be perfectly sound when containing more than the usual quantity of lime, while a cement low in lime may be entirely unsound, due to careless manufacture. The analysis of a cement will show the uniformity in composition of the product from individual mills, but will furnish little or no indication of the quality of the material. Occasional analyses should, however, be made for record and to determine the quantity of sulphuric anhydride and magnesia present.

The ground clinker as it comes from the mill is usually quick setting, which requires correction. This is usually accomplished by the addition of a small quantity of more or less hydrated calcium sulphate, either gypsum or plaster of paris. Experience and practice have shown that an addition of 3 per cent. or less is sufficient for the purpose. Three per cent. of calcium sulphate ($CaSO_4$) contains about 1.75 per cent. sulphuric anhydride (SO_3), and, as this has been considered the maximum quantity necessary to control the time of set, the specification limits the SO_3 content to 1.75 per cent.

The specification prohibits the addition of any material subsequent to calcination except the 3 per cent. of calcium sulphate permitted to regulate time of set. Other additions may be difficult or impossible to detect, even by a careful mill inspection, during the process of manufacture, but as the normal adulterant would be ground raw material, an excess of 'insoluble residue' would reveal the addition of silicious material, and an excess in "loss of ignition" would point to the addition of calcareous material when either is added in sufficient quantity to make the adulteration profitable.

The effect of relatively small quantities of magnesia (MgO) in normal Portland cement, while still under investigation can be considered harmless. Earlier investigators believed that as magnesia had a slower rate of hydration than lime, the hydration of any free magnesia (MgO) present would occur after the cement had set and cause disintegration. The effect of magnesia was considered especially injurious when the cement was exposed to the action of sea water. More recent investigation has shown that cement can be made which is perfectly sound under all conditions when containing 5 per cent. of magnesia, and it has also been found that the lime in Portland cement exposed to sea water is replaced by magnesia. The maximum limit for magnesia has been set at 4 per cent., as it has been established that the quantity is not injurious, and it is high enough to permit the use of the large quantities of raw material available in most sections of the country.

For some time, therefore, it will be better for the engineering profession to depend on the standard physical tests, at least until chemical analysis can furnish sure indication of the quality of the material.

EDITORIAL COMMENT.

Plumbers and gasfitters have arisen to the dignity of Sanitary Engineers. The advance guard who prepare the ground for a visiting circus class themselves as Circus Engineers. The profession is ever broadening.

A prominent contractor states that in one case the saving of concrete by reducing the size of columns on successive floors was $2.30 per column; on the other hand the increase in form cost was $5.70 per column, entailing a net loss of $3.40 per column. This is a very good example of why it is cheaper to use the same size column on successive floors than to reduce the dimensions. To avoid frequent changes in column sizes column reinforcement may be varied in successive stories.

* * * *

In this issue will be found the full report of the inquest into the collapse of the south wall of the Neilson building. We have endeavored to present the salient points of the evidence given by the several witnesses. Many matters of interest to the engineering profession were brought out, as may be seen by a perusal of the article. The evidence as given by Professor C. H. C. Wright was particularly clear, and his statements give a logical presentation of the reasons for the failure, with suggestions for changes in the city by-law, which the City Architect and the city will do well to heed.

EFFICIENT WATERWORKS.

The operation of the municipal waterworks of Berlin, Ont., under commission rule, has proved thoroughly successful. The plant was first installed in 1888, by Messrs. Moffett, Hodgkins and Clarke, of Syracuse, N.Y. They secured their supply from a pond, and had a ten-year franchise.

When it expired the ratepayers decided to take over the plant, at a valuation of $102,000. Then there were only 13 miles of mains, 104 hydrants and 732 consumers.

Under civic ownership, the system has grown to that stage where there are now 34 miles of mains, 218 public and 16 private hydrants, and 2,872 consumers, of which 2,229 are on meters.

The water supply has been greatly increased. Artesian wells have been sunk and the water is being pumped by the air-lift system.

But what affects the consumers most of all is the reduction in the rates and a purer supply of the drinkable.

Under private ownership, the rates for an ordinary house with full plumbing and lawn service, was $19 a year. Now, under municipal ownership, it is $4.59 for the same service, per year.

The minimum charge is now $1.12½ per quarter, for 6,250 gallons or less, and the rates for larger consumers range from 17 to 6 cents per thousand gallons, according to the quantity used.

In addition to the reduction of the rates to the private consumers, the charge for street hydrants, for protection from fire, have been reduced from $50 to $25, and there is now no charge for meter rentals.

The profits from the system, which have been used in extending the service, and the original debenture debt has been reduced to $85,465. And after writing off $32,000 for depreciation, the department shows a balance of assets over liabilities of $141,642.

The commissioners have the confidence of the citizens as there have been few objections—in the way of candidates to oppose members—raised.

The growing needs of the new city have made it necessary to enlarge and improve the system and the confidence of the ratepayers was shown when they passed a by-law to grant $100,000 for this purpose. Some of the contracts have been already awarded and it is expected that the work will be completed this year.

THE DESIGN OF INDUCTION MOTOR SHAFTS TO RESIST DEFLECTION.

By Mr. Bradley T. McCormick.*

The designer of electrical machinery is constantly confronted with the problem of reconciling the requirements of good electrical characteristics with reliability of service. A certain proportion of mechanical dimensions will give a machine which shows up best from the standpoint of electrical performance curves, but the proportions may be so extreme from the mechanical standpoint as to make the machine utterly unreliable.

A striking example of conflicting mechanical and electrical requirements is the polyphase induction motor as applied to industrial purposes.

In order to keep the power factor as high as possible it is necessary to design induction motors with the air gap or clearance between the rotor and stator as small as is consistent with reliable operation. Every precaution must be taken to obtain an accurate bore of the inside surface of the stator and a perfectly true rotor, with shaft and bearings of sufficient stiffness to limit the deflection to a small percentage of the normal length of the air gap.

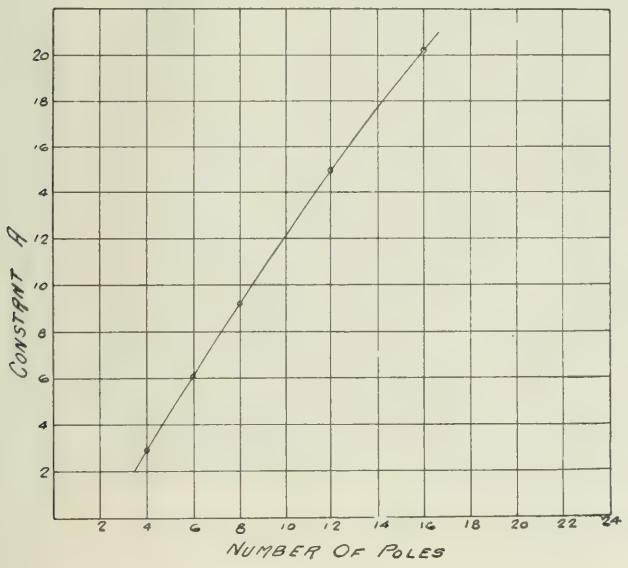


Fig 1

If the air gap is perfectly uniform, the radial magnetic attraction between the rotor and stator is the same at all points and is completely balanced; but if the clearance between the rotor and stator becomes reduced at any point, the decrease in reluctance of the air gap at this point and the increase in reluctance at a point diametrically opposite, set up an unbalanced magnetic attraction, tending to spring the rotor still more out of centre, and in some cases so far as to make it "rub" against the stator.

Fisher Hinnen, in his book entitled "Continuous Current Dynamos," gives the following formula for unbalanced magnetic pull:

$$z = \frac{\left(\frac{B}{1000}\right)^2 S}{72} \frac{x}{\Delta k} A \qquad (1)$$

while Behrend, in a paper before the American Institute of Electrical Engineers, November 23rd, 1900, gives for induction motor, a formula which in a slightly modified form is as follows:

$$z = \frac{\left(\frac{B}{1000}\right)^2}{\alpha} \frac{R c}{72} \frac{2 x}{\Delta} \% \qquad (2)$$

The meaning of the symbols is shown in the table at the end of the paper, all values being expressed in the inch system. The constant α is a fringing coefficient slightly greater than unity, and takes account of the higher reluctance of the air gap of a toothed armature as compared with a smooth core. The values of α given by Carter Electrical World and Engineer, (Vol. 38, Fig. 384), are recommended, but the following gives values of α which are close enough for all practical purposes. (See Fig. 2.)

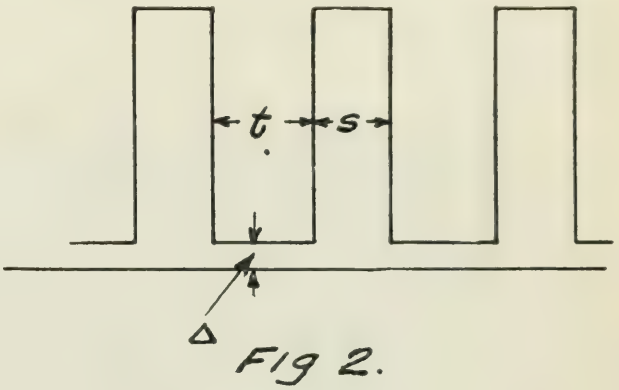


Fig 2.

$$\alpha = \frac{t + s}{t + \frac{5 \Delta s}{5 \Delta + s}} \qquad (3)$$

For direct current machines or alternators having salient poles, the flux density is fairly uniform over the pole face and may be taken as

$$B = \frac{\varphi}{\tau L \alpha} \% \qquad (4)$$

while in induction motors the flux density over a pole pitch approximates a sine distribution, so the square root of mean

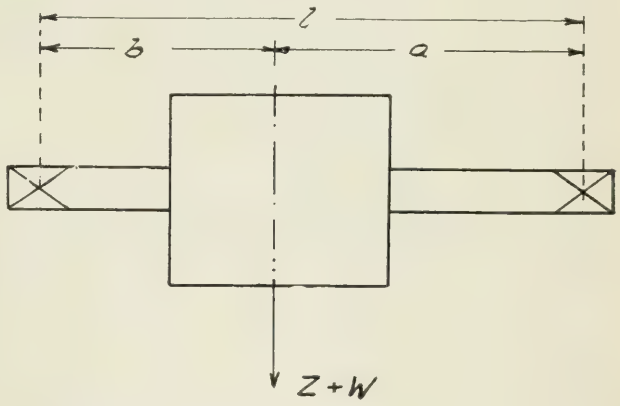


Fig 3

square value should be used for B, since it enters into the formula for unbalanced pull, in the second power. For induction motors use

$$B = \frac{\varphi}{\tau L} \frac{\pi}{2} \frac{I}{\sqrt{2}} \alpha = 1{\cdot}11 \frac{\varphi}{\tau L} \alpha \qquad (5)$$

* Electrical engineer for Allis-Chalmers-Bullock, Ltd., Montreal.

The following is used for air gap area, the factor % being unity in induction motors,

$$S = \frac{\tau L \%}{\alpha} \qquad (6)$$

Fisher Hinnen's formula (1) although evidently intended more for direct current machines, checks fairly well with Behrend's formula (2).

We shall first assume that, due to imperfect assembling or non-uniformity of the stator bore, there is an initial eccentricity equal to e. When the machine is excited this initial eccentricity gives rise to an unbalanced magnetic pull Z, which increases the eccentricity to an amount $x = (e + d)$ to such a value that the magnetic pull, plus the weight of the rotor, is just balanced by the tendency of the shaft to resist further flexure.

And the deflection due to weight alone is,

$$\delta = \frac{W a^2 b^2}{3 l E I} \qquad (10)$$

The total eccentricity is,

$$x = d + e \qquad (11)$$

The stress in the shaft can be calculated from the total pull W + Z, while the deflection of the shaft from its natural unstrained position is,

$$\text{Total deflection in shaft} = d + \delta \qquad (12)$$

As a method of procedure in applying the above formulas, the writer would suggest that, having decided upon the length of the air gap Δ, a shaft be chosen that appears to be large enough and then checked for stiffness on the assumption of a reasonable initial deflection. As a first approximation in determining the size of the shaft, it is considered good practice to adopt a shaft large enough to limit the deflection due to weight alone, to one-tenth the normal air gap. For checking purposes, however, the initial eccentricity should preferably be assumed somewhat greater than $\Delta/10$.

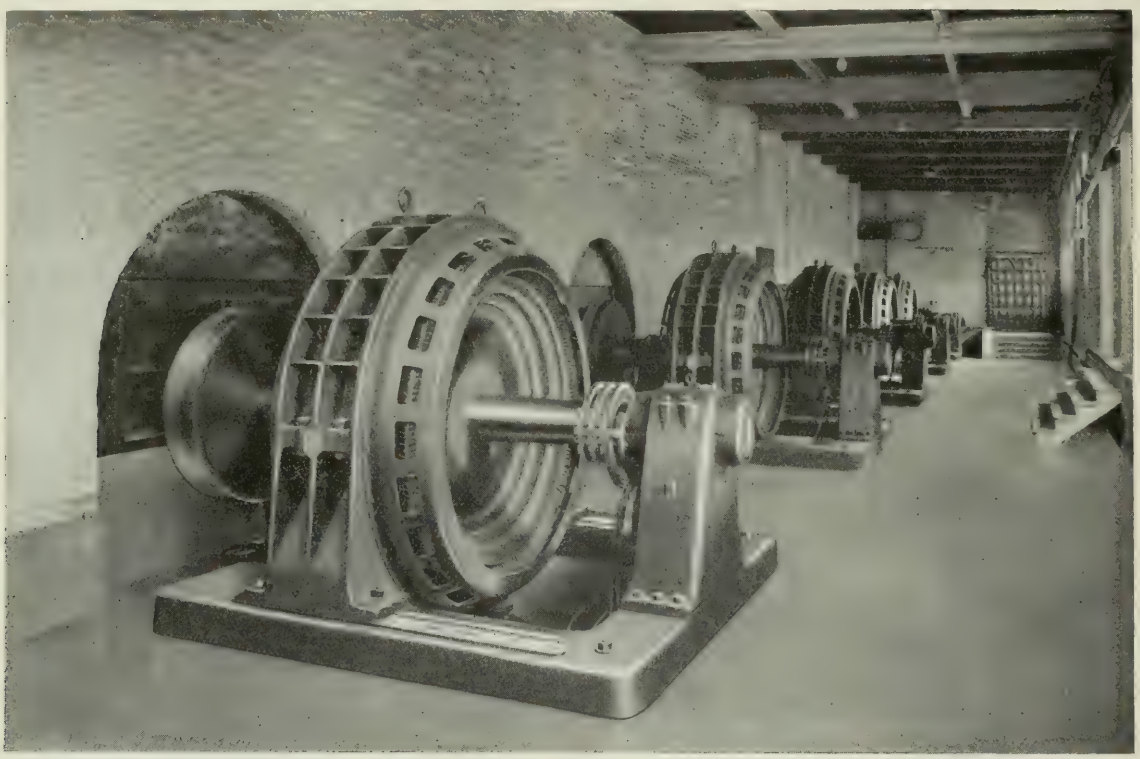


Fig. 4.—Five Induction Motors, Each 1,200 h.p., Driving Grinders, Union Bag and Paper Company, Three Rivers, Que.

Using Fisher Hinnen's formula (1)

$$z = \frac{\left(\frac{B}{1000}\right)^2 S}{72} \cdot \frac{x}{\Delta k} A = K (e+d) \qquad (7)$$

When K is the magnetic pull per inch of displacement of the rotor from a central position, which from formula (1) equals

$$k = \frac{\left(\frac{B}{1000}\right)^2 S A}{72 \Delta k} \qquad (8)$$

Leaving the weights out of consideration, but taking the deflection due only to the magnetic pull Z, we have. (See Fig. 3).

$$d = \frac{z a^2 b^2}{3 l E I} = \frac{K (e+d) a^2 b^2}{3 l}$$

Solving for d

$$d = \frac{e}{\frac{3 l E I}{K a^2 b^2} - 1} \qquad (9)$$

The motors were to be subjected to rather rough service as they were designed to drive grinders in a pulp mill, where the torque often suddenly rises to 50 or 100 per cent. above normal when the logs are fed too fast to the grinding stones. The wide space between bearing centres necessary to permit lateral movement of the yoke, and the small air gap necessary to obtain good power factor with open slots, requires that special consideration be given to the design

As a practical example we will apply the foregoing formulas to some 1,200-horse-power induction motors which the writer was recently called upon to design. The specifications called for motors constructed in such a way as to allow the yoke to slide along the base in a direction parallel to the shaft, far enough to completely uncover the rotor winding, in order that the coils might be readily accessible for repairs.

of the shaft, in order to secure stiffness against deflection due to the weight of the rotor and unbalanced magnetic attraction between the rotor and stator. This point will be readily appreciated by reference to the heavy shaft and long

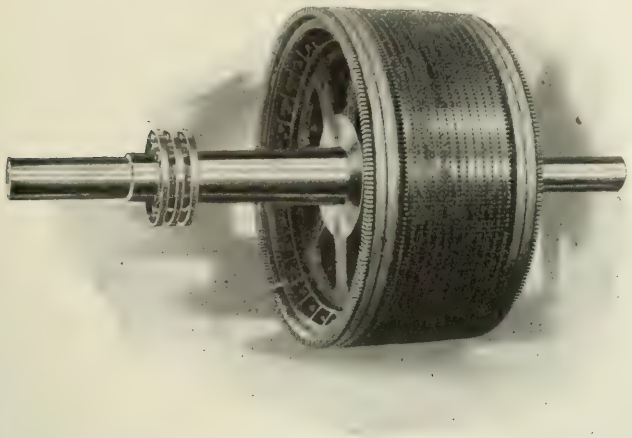


Fig. 5.—Rotor, Showing Long Space Between Bearing Centres.

space between bearings, as shown in Figs. 4 and 5. The following values apply to these motors:—

A = 17.5 for 14 poles (See Fig. 1).
L = 32.2 sq. in.
φ = 6.7 x 10^6.
Δ = .09".
k = 1.115 from calculated saturation curve.
Diam. of shaft 14" at hub.
I = 1880 = moment of inertia of shaft.
e = assume .02.
α = 1.37.
w = 15,000 lbs.
a = 72" (See Fig. 6).
b = 37" (See Fig. 6).

Calculated Values.

Form (5) $B = 1.11\frac{\varphi}{\tau L} = 1.11\frac{6.7\times10^6}{32.2}\times 1.37 = 31700$

Form. (6) $S = \tau L\,\%/\alpha = 32.2\times 1/1.37\times 235$ sq. in.

Form. (8) $K = \frac{\left(\frac{B}{1000}\right)^2 S\,A}{72\,\Delta\,k} = \frac{31.7^2\cdot 235\times 17.5}{72\times .09\times 1.115} = 560{,}000$ lbs.

Form. (9) $d = \frac{e}{\frac{3\,l\,EI}{K\,a^2\,b^2 - l}} = \frac{.02}{\frac{3\times 109\times 30\times 10^6\times 1880}{560000\times 72^2\times 37^2} - 1} = .0055$

Form. (11) $x = d + e = .0055 + .02 = .0255$

Form. (10) $\delta = \frac{W\,a^2\,b^2}{3\,l\,E\,I} = \frac{15000\times 72^2\times 37^2}{3\times 109\times 30\times 10^6\times 1880} = .00577$

Form. (12) total deflection of shaft $= d + \delta = .0055 + .00577 = .01127$

Form. (7) $z = \frac{\left(\frac{B}{1000}\right)^2 S}{72}\,\frac{x}{\Delta\,k}A = \frac{31.7^2\times 235}{72}\times\frac{.0255}{.09\times 1.115}\,17.5 = 14200$

Total Pull on shaft = W + z = 15000 + 14200 = 29200 lbs.

Symbols.

B = density per sq. in. in air gap, the increase due to fringing being included.

S = air gap area per pole corrected for fringing $= \frac{\tau L}{\alpha}$ for induction motors $= \frac{\tau l}{\alpha}$ for salient pole machines.

Δ = actual air gap (normal).
e = initial eccentricity with no excitation, due to imperfect centring.
d = additional deflection due to magnetic pull.
χ = total amount of eccentricity = d + e.
A = a constant depending upon the number of poles. (See Fig. 1).
For large number of poles, A = 1.25 × number of poles.
k = (gap + iron) A.T. ÷ gap A.T.
K = deflection per inch of eccentricity $= \left(\frac{B}{1000}\right)^2$ S.A./72 Δ k.
a and b = distance from armature centre to bearing centres, in inches.
l = distance between bearing centres, in inches.
E = modulus of elasticity of shaft.
I = moment of inertia of shaft about neutral axis = $1/64\pi D^4$.
W = weight of armature, in pounds.
δ = deflection of shaft due to weight alone.
ϕ = flux per pole.
τ = pole pitch.
α = Carter coefficient for fringing.
L = effective length of iron parallel to shaft. (Fisher Hinnen's formula).
R = radius of stator, inches.
c = effective length of iron parallel to shaft. (Behrend's formula).
% = pole arc ÷ pole pitch. This is necessary to make Behrend's formula applicable to alternators and D.C. machines.
D = diameter of shaft at hub.
t = width of tooth at air gap.
s = width of slot.

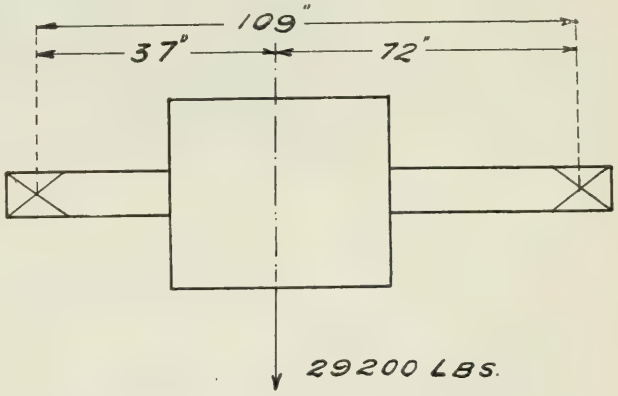


Fig. 6.

THE DRYDOCK AT QUEBEC.

Mr. F. G. Wilson, who has prepared a report on the proposed Quebec drydock, has placed his papers in the hands of the proper government officials. Mr. Wilson has gone over the ground and made a careful examination of all the plans, including the latest submitted by Mr. Cravin.

Besides examining the merits of the different plans and the different sites, he has taken information from a number of practical shipping men with regard to the ice conditions, etc., and has sounded them as to their opinions on the merits of the two sites. Naturally these opinions vary somewhat, but from what has been learned it is understood that the site will be on the south shore of the St. Lawrence. Mr. Wilson is from Great Britain and is considered an expert in matters pertaining to drydocks.

THE HYDRO-ELECTRIC PLANT OF THE SIMCOE RAILWAY AND POWER COMPANY.

An interesting hydro-electric installation which has been completed and in service for some months is the plant of the Simcoe Railway and Power Company, at Big Chute, on the Severn River. It serves with electric power the towns of Midland, Penetang, Victoria, Ontario Harbour, Port McNicholl, Coldwater, Barrie and Orillia, in the counties of Simcoe and Muskoka. The installation is the largest hydraulic development in the Georgian Bay District and has an ultimate capacity of 7,000 h.p.

Development was started in the fall of 1909, and in May, 1911, 4,200 horse-power was developed and commercially available in Midland. The power market will include the municipal and industrial operations in the towns in the vicinity and in addition the flour mills and immense grain elevators now constructed after the determination of the Canadian Pacific and Grand Trunk Railways to make the district the terminus of the lake carrying portion of the grain route from the West. The natural market possibilities are large and will doubtless soon necessitate the further extension of the Big Chute plant and the development of the Little Chute and the falls at Port Severn, in the near future: the latter sites are now held by the power company.

View of Generating Station.

The general location of the Severn River waterway system is such as to drain all that portion of Central Ontario in the vicinity of Lake Simcoe and comprises a total watershed area, above the Big Chute, of about 2,250 square miles. This area is constituted as follows:

Land area, including small streams, 1,800 sq. miles.

Water area: Lake Simcoe, 300 sq. miles; Lake Couchiching, 15 sq. miles; Sparrow Lake, 5 sq. miles; other various lakes and large rivers, 130 sq. miles.

The general nature of the country drained has two characteristics. The southerly portion of the area comprises rolling and flat country and the northerly portion, rough, rocky and hilly regions. At one time the area was wooded but recent lumbering operations have deforested the northerly portion very rapidly, only a portion at the extreme north-easterly end and isolated districts in the north-west still remaining. Probably seventy per cent. of the area may be generally termed settled, the southerly portion being fairly dense and the north, sparsely. Settlement, however, is proceeding in the north and the streams are consequently being improved and lands drained. Owing to the large proportion of lake area in the watershed the discharge of the Severn River is comparatively steady throughout most of the year, as the lakes act as regulating reservoirs.

Based on continual measurements during the last twelve years, the flow of the Severn above the Big Chute locality for practically the whole year will, it is estimated, not fall below 950 cubic feet per second excepting from the middle of January to the middle of March. Water control of the head lakes will effectually conserve the water supply and, deforestation having reached its limit, reforestation will gradually retard the run-off to benefit the continual flow.

Temperatures in this district run very low in the winter, short periods at 30 degrees below zero not being uncommon. The result of this is the formation of very thick sheet ice on the quiet waters of the river and of a certain amount of frazil ice in the falls and rapids as the broken water is exposed to the cold air. The Big Chute site is fortunately situated in this respect, as for a distance of ten miles above the chute the few very slight "swifts" are flooded out. At Ragged Rapids, ten miles above the Big Chute, the town of Orillia has developed power so that those rapids have been flooded and during the winter practically all the water is passed through their hydraulic system without coming in contact with the air. It is evident that there is practically no opportunity for the formation of anchor or frazil ice which would affect the Big Chute plant.

The Severn River in the locality of the development has three points of discharge over the bridge forming the falls. These are Lost Channel, Six Mile Channel, and Big Chute; the former are distant 2½ and 1 mile upstream from the Big Chute. The river at Big Chute makes a straight rapid series of falls through a narrow gorge for about 300 yards after which the stream divides, part going straight to the lower pool, the main part, however, passing to one side into a middle pool, thence out into the lower pool over a small cascade 2 feet in height. The total natural fall under normal conditions is 50 feet.

The general hydraulic portion of the development included the construction of dams, intake, canal, forebay, gates, spillway, penstocks, power station, hydraulic machinery and tail discharge, the whole providing for a development of 58 feet head.

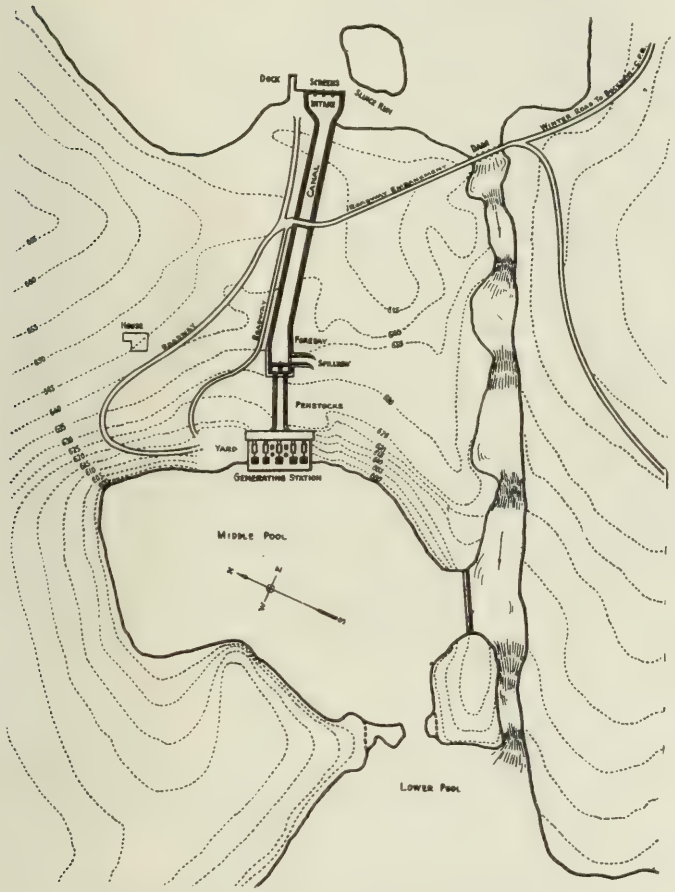
The Big Chute dam consists of massive piers and concrete sills with stop logs and spill crests. The piers are bridged over and form the roadway bridge for the winter road and for the road from a boat landing some two miles below to which the river is navigable from Port Severn on the Georgian Bay; the winter road is direct to Buckskin Station on the Toronto-Sudbury line of the Canadian Pacific Railway.

Lost Channel dam is located in a narrow gorge and consists of stop logs seated in shore piers. The Six Mile Channel dam is of similar construction to the Big Chute dam.

The water is carried through a canal from the upper level to the forebay at the brow of the rocky ridge above the middle pool and from thence to the power house through steel penstocks and is discharged from the turbines into the middle pool underneath the power house and thence into the lower pool below the foot of the chute. The chute is dammed where dividing at the "Twin Falls" to compel the overflow water to go directly to the lower pool; the rocky

ridge between the middle and lower pools has been removed and the difference in level gained for the lower head.

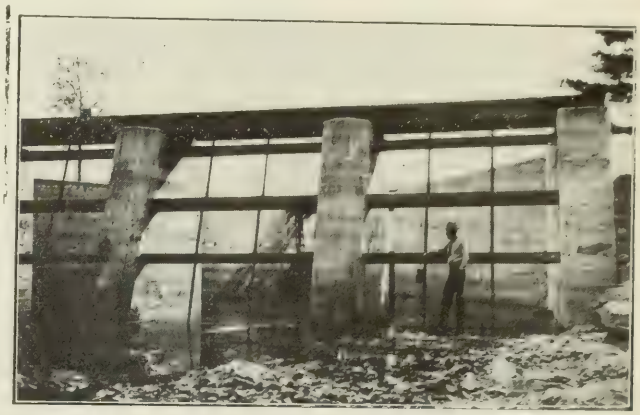
The canal entrance widens out to form an intake which is protected with four sets of racks supported by the concrete piers. The photograph of the intake shows the piers and framing for racks and further shows the canal in the background. Racks are of iron with wooden tops extending out of the water so that the frost from the air cannot be conducted to the iron portion in winter, thus preventing the freezing up of the openings between rack bars. The concrete is built up on the solid bed rock and continues along as lining for the canal to the forebay. Stoop log seats are arranged at the entrance from intake to canal so that the head-water can be shut off entirely from the canal. A sluice run has been excavated alongside the intake in the river bed to take care of the ice and debris.



Plan Showing General Layout of Headworks and Generating Station.

The canal is about 500 feet long and terminates in a forebay from which two steel penstocks, nine feet in diameter, lead down to the power house. The forebay is protected by a housing which will be heated in extreme weather; a curtain of 8 x 10 timber extends from the housing sills downwards into the water and both encloses the air space in the forebay and acts as an ice and trash boom in front of the racks. A spillway with adjustable stop-logs, forward of the curtain, regulates the water level and discharges debris; a small sluiceway is placed in front of the racks, in the housed portion, and carries out any debris caught by the racks. Both spillway and sluice discharge into a natural gully in the rock and flow down to the lower pool. The racks are of iron bars arranged for easy handling and raking. The penstock entrance has a large bell-shapel mouth about 13 feet in diameter; stop-logs with handling winches act as penstock gates.

Up to this point the development is for the ultimate output, but at present but one of the penstocks is installed. The total machinery provided for will be 6,800 h.p. of hydraulic turbines; at present 4,200 of this is installed, in three main units and two exciters, leaving two main units to be installed later. The third power turbine will be fed ultimately from both penstocks with a Y connection and the exciter will be also arranged to connect to either source.



Intake to Power Canal, Unwatered—Severn River.

The penstock is carried on several concrete piers for about 150 feet down the slope and turns along the rear of the power house, terminating in a surge tank extending to an elevation four feet above that maintained in the forebay. Nos. 1 and 2 turbines are connected with the penstock by diverging feeders and No. 3, the centre unit, is connected by the present portion of the Y connection. No relief valves are installed on penstock or turbines, the surge tank being ample to take care of all pressure changes.

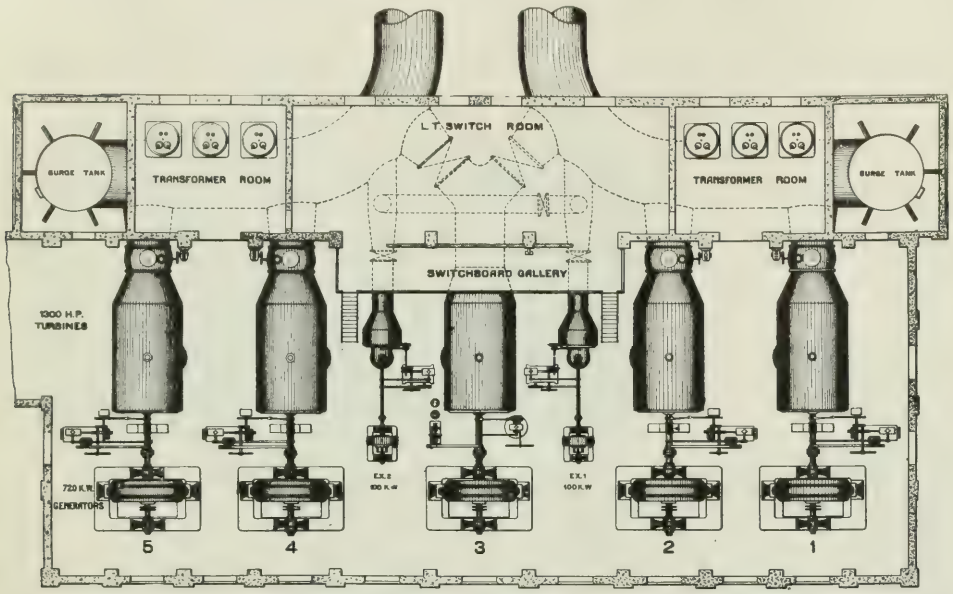
The power house is built on a ledge of rock extending into the lower pool and sufficient excavation was made into the cliff behind to allow the foundations to lie completely on the ledge. The piers and foundations are of massive concrete extending about 23 feet from bed rock to floor level. All piers and walls are tied into one another above the water line, and again at the floor line, by reinforced struts and

Diverting Dam at Big Chute, Severn River.

beams making an essentially homogeneous structure. The tail race extends longitudinally under the floor line and has large openings to the tail water between the generator piers and through arched openings in the outer wall.

The walls are of concrete slabs between heavy pilasters, the pilasters carrying the crane rail and roof trusses. The

rear portion of the station has the floor eleven feet higher than the generating room floor leaving space for the penstock and feeders underneath; this floor contains the low tension switchboard and its equipment and the transformers while a second floor above the switching room contains the high tension switching and line equipment. The rear portion of the building has a heavy concrete roof carried on



Section Through Generating Station, Showing Arrangement of Turbines, Generators and Transforming Equipment.

reinforced beams while the roof of the generating room is 1¼-inch matched pine carried on heavy wooden purlins which are hung by wrought iron hangers from the steel roof trusses. Both roofs are covered with several layers of asbestos felt laid in asphalt cement; the Johns-Manville Company were the contractors for this portion of the work. The general works and the power station were constructed by Messrs. Pratt & MacDougall, of Midland.

The turbines were built by the William Hamilton Company, of Peterborough, Ontario, are are of the "Samson" type. The power turbines are designed for 1,300 horsepower capacity under 56 feet head and a speed of 300 revolutions per minute. The double runners, of the Francis type, are of bronze, 35 inches in diameter, and the water discharges into a single steel draft tube inclined towards the front of the power house. The turbine case is carried on a series of heavy "I" beams spanning the tail race.

A 66-inch vertical gate valve is set in the horizontal feed pipe between each turbine and the penstock; the valve is erect in Nos. 1 and 2 units while in No. 3 the stem is downwards and is protected by a concrete housing. All 66-inch valves are being arranged for alternating current motor operation while the auxiliary hand mechanism will allow for complete opening or closing in about two hours by one man. The valves have strongly ribbed cast iron bodies with bronze mountings on all bearing and rubbing faces. Each valve is tested to a working pressure of 50 lbs. per square inch and operation under 75 feet head. A six-inch by-pass with valve is provided with each.

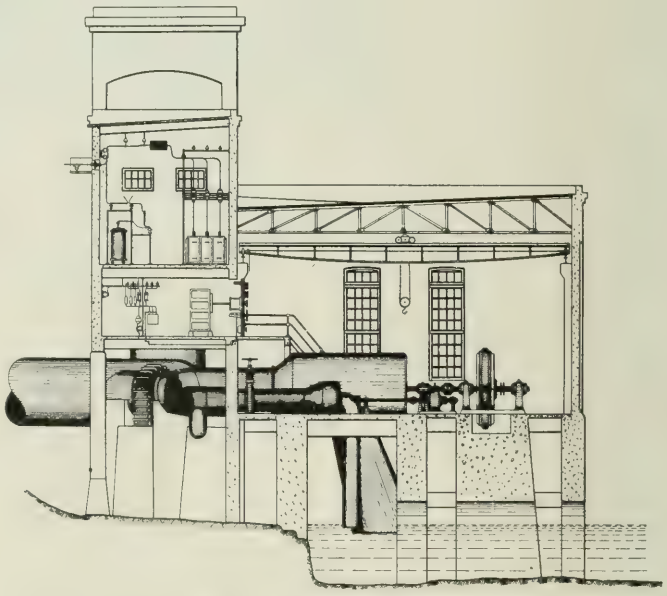
The exciter turbines are of the single runner type, 17 inches diameter, and are capable of producing 200 horsepower under 56 feet head at 580 revolutions per minute. The valves on exciter feeders are 30 inches in diameter.

The hydraulic turbine governors are all of Lombard oil pressure design, types N and Q 7½ being installed for power turbines and type P for exciters. The governors in combination with the surge tank on the penstock, and the heavy fly-wheel effect of the generators, have given excellent results on test while with the surge tank acting and full load thrown off the turbines the pressure rise in the turbine cases is hardly appreciable.

The power generators are of Canadian Westinghouse Company's manufacture, as is practically the whole of the electrical equipment. These generators are of 900 kv.a capacity, 2,200 volts, 60 cycles, three phase at 300 revolutions per minute. The armatures are wound in three slots per pole per phase, the slots being open; the field is revolving and the rotor will withstand the stresses of a runaway speed 75 per cent. in excess of normal.

The exciters are of 100 kilowatts capacity at 125 volts and are controlled by means of a Tirrill regulator to automatically produce a varying strength of field on the power generators to maintain a constant voltage at the end of the 25-mile transmission line. The two exciters are direct connected to their turbines. The turbines are arranged to take water from either penstock, when the second penstock is installed or for each to be fed from a separate penstock, thus providing for continuity of exciter current.

The current from all generators on the main floor is carried through cables, laid in fibre conduits, to the switchboard on the gallery and from thence to the transformers and ultimately through the high tension switching room to the line.



Plan of Generating Station.

The transformers are three single phase units agregating 1,800 kilowatts capacity. These are connected in delta so that in case of accident to one unit the two other may be used for continuing the service. The voltage ratio is 2,200 to 25,000, the latter being the transmission voltage. Water for transforming cooling purposes is supplied through the station water piping from the stand pipe; a cleaning strainer is attached to the source.

The electrical circuits are arranged so that each generator may be switched on either of two sets of 2,200 volt bus-bars. Each of these bus-bars feeds into one 1,800 kw. transformer bank through a circuit breaker and the two transformer sets may then be connected in parallel by a tie oil switch. Each transformer set on the high tension side feeds to a 25,000 volt bus-bar to which the transmission line is connected through the line circuit breaker. When the second transmission line is constructed the high tension bus may be divided so that each of the two transformer sets may feed their corresponding lines independently.

The switchboard consists of twelve black marine finish marble panels which are arranged in three groups, spaced by the concrete columns which extend from the switchboard gallery floor, so that the five generator panels and the bus tie switch panel are between the columns while on the left is the direct current board of three panels, including the Tirrill regulator and on the right are the two transformer panels (one blank at present) and the line panel. The gallery extends six feet into the generator room while behind is ample room for the 2,200 volt bus and switch structure and the generator rheostats. The rheostats are carried on concrete pedestals to allow for ventilation, and are operated by shafts in a straight line between rheostat handle on the switchboard and the face plate on the rheostats.

In the transformer room disconnecting switches are arranged inside the low and high tension delta connections so that any single phase transformer can be temporarily cut out. The leads on the high tension side are carried through a wall opening into the line room where the three 25,000 volt oil switches, the electrolytic lighting arresters and the choke coils are located as shown in one of the accompanying photographs.

The transmission line outlets are at the rear of the power house and consist of porcelain outlet insulators in a 14-inch opening in the concrete wall. The outlet is protected outside by a hood of a one-half section of a 42-inch corrugated iron culvert carried on steel angle brackets inserted in the wall; this has proven a very cheap and effective outlet covering.

The transmission line is approximately 25 miles long, the route being south-west to Waubaushene on Georgian Bay, and thence to Midland, generally following the roadways along the Georgian Bay shore line. Half of the distance, from the Big Chute to Waubaushene, is over the company's right-of-way, which has been cleared and laid out for two parallel transmission lines.

The poles are generally 35 feet in length graded to conform to the profile of the route. The conductors are No. 00 B & S aluminum cable supplied by the Northern Aluminum Company and are carried on 35,000 volt porcelain insulators spaced in an equilateral triangle, forty-two inches apart with the apex at the top of the pole. A photograph shown herewith indicates a typical portion of the line. Special pole arrangements were made for railway and telephone crossings.

A telephone line extends from Big Chute to Midland, carried on the pole line. Heavily insulated transformers are placed at each terminal with the local services on the secondaries so that no accidental high voltage on the telephone line can be dangerous to the telephone operators.

At Waubaushene, the Matchedash Bay arm of Georgian Bay is about 2,000 feet across and two spans are made, 1,153 and 858 feet respectively. The longer span also crosses the ship channel which is close to the west shore and the Government requires 150 feet clear at this point between wires and water, necessitating a 175-foot tower; the centre and east shore towers are 88 feet high, giving a forty foot clearance on the 858 foot span. The long span is made with copper cable of 7 No. 9 B & S strands, while the 858-foot span is made with 300,000 c.m. aluminum cable, the copper and aluminum being spliced together at the centre tower with a special aluminum clamping device, while the other ends are clamped to a 2 unit suspension insulator. The cross arm decks of the shore towers are fitted with iron sheaves and turnbuckles, so that tension may be put on the steel cable supporting the insulators to allow for adjustment of the sag, should occasion demand. The connecting cables are attached to the span cables at the suspension insulators and are carried down the sides of the towers on insulators to within 50 feet of the ground, and from thence to the pole line. The towers are arranged with gusset plates at the top to accommodate an additional deck so that a second line may be eventually carried above the first.

At Midland the company has acquired a plot on the outskirts for the sub-station and construction yard. The sub-station is of brick arranged for extension as the market may demand. The present equipment has transformers, line apparatus and a switchboard similar to those of the generating station. Distribution is at 2,300 volts to Midland and the surrounding district. The Hydro-Electric Commission undertakes the distribution in Midland and Penetanguishene.

The Simcoe Railway & Power Company is formed of well known business men connected with the various large concerns in Midland, the officers being: W. J. Lovering, Toronto, president; W. Finlayson, Midland, secretary, and D. L. White, Midland, treasurer.

The engineering of the development was carried on by Messrs. C. H. and P. H. Mitchell from its inception. The resident engineers were Murray C. Hendry, B.A.Sc., during construction, and O. L. Flanagan, B.A.Sc., during installation.

EDMONTON NOTES.

The Allsip Brick and Supply Company have about completed installation of their plant at Edmonton at a cost of $100,000, and will in a few days begin turning out brick at the rate of 85,000 per day. The Hardstone Brick Company are busy installing extensive machinery. The Edmonton Brewing and Malting Company have let a contract for a fireproof building which will be equipped with the most thoroughly modern plant at a total cost of approximately $450,000. Work is progressing on a handsome $100,000 office for the Royal Bank. Rapid progress is being made on the $350,000 addition to the Tegler Block and the $250,000 office building for the Canadian Pacific Railway. Contracts aggregating over $250,000 have been let for an office block to be erected by the city.

Steel work is progressing rapidly on the big Canadian Pacific Railway bridge and the work of grading for their line into the heart of the city is proceeding. The Athabasca Landing branch of the Canadian Northern Railway has reached that point, and construction trains are now running. The Brazeau branch of the Canadian Northern Railway has been opened for traffic to Rocky Mountain House. The Grand Trunk Pacific branch to Calgary is being pushed.

The Hudson's Bay Company's sale of a portion of their reserve, which opened on 14th May and closed to-day, was an extraordinary indication of confidence in Edmonton's continued development. Though the lots offered were in a district absolutely undeveloped, the entire 1406 lots offered were sold at figures aggregating $4,343,400. Lots averaged 50 x 150 feet.

PUBLIC ROADS, NEW JERSEY, U.S.A.

By E. A. James, B.A.Sc.*

Since the passage of the State Aid Law in New Jersey the Commissioners of Public Roads in that State have spent $3,230,336, and completed 1,778.896 miles, making an average cost of $2,045 per mile.

The class of road varies with the location, but out of 13,550,000 square yards built 6,082 square yards was macadam, 2,394,000 square yards Telford, 4,119,320 square yards gravel, 449,100 asphalt macadam and 244,851 square yards of amiesite, the balance being made up of small quantities of shell, bogore, etc., etc.

Yardville-Allentown Macadam Road, Before.

Many of their costs are very interesting, but as an example we will take the Yardville and Allentown Road, 3.04 miles long. This was built as a macadam highway and treated with heavy asphaltum oil, and was built under the following specifications:—

All stone must be as nearly cubical as possible, broken with the most approved modern stone crushing machinery. It must be of trap or approved native rock, free from all screenings, clay, soil or other objectionable substances, of uniform size and of the same kind and quality as sample. It must show a fresh, crystalline surface.

Macadam foundation or two and one-half-inch stone shall be broken stone, which must pass through a three-inch ring and catch on a two-inch ring.

Macadam second course or one and one-half-inch stone shall be broken stone, which must pass through a two-inch ring and catch on a one-inch ring.

Macadam surface or three-quarter-inch stone shall be broken stone, containing not over 5 per cent. of material retained on one-inch circular openings or 8 per cent. which will pass one-half-inch circular openings.

Dustless screenings shall be broken stone taining not over 5 per cent. of material retained on ⅝-inch circular openings or 8 per cent. which will pass one-quarter-inch circular openings.

Dust shall be broken stone and include all material which will pass one-quarter-inch circular openings. but must be free from soil, loam or clay.

Length of stone-bed, 17,992.5 feet.
Width of stone-bed, 14 feet.
Depth of stone-bed, not less than 6 inches deep.
Average width of shoulders, 7 feet.
Average total width of improved roadway, 28 feet.

Excavations, 8,150 cubic yards., at 50 cents; total.	$ 4,075.00
Macadam, 28,736 square yards, at 94 cents; total.	27,011.84
Macadam driveways, 564 square yards, at 50 cents; total	282.00
Underdrains, extra, approved by State, 1,500 lineal feet, at 20 cents; total	300.00
Extra, reconstructing class B macadam, 42⅔ square yards, at 94 cents; total	40.11
Extra, reconstructing driveway, macadam, 16 1/9 square yards, at 50 cents; total	8.06
Extra, reconstructing driveway, macadam, 33⅓ square yards, at 50 cents; total	16.83
Total cost	$31,733.84

Maximum grade before .....3.00 per cent.
Maximum grade after .....2.35 per cent.

As was pointed out in the opening paragraph, gravel constituted an important material of construction. As an example of a gravel road the Monmouth Boulevard will serve to illustrate. This road is 2.6 miles long, and was built under the following specifications:—

Road gravel A is to be composed of pebbles, chert, sand, clay and oxide or hydrate of iron, in such quantities that the gravel will pack under pressure into a hard, dense pavement. It will be judged solely by comparison with the samples furnished.

Road gravel B is gravel not deemed suitable for surface work, but may, on approval of sample by the engineer and State Commission of Public Roads, be used for foundations of gravel roads.

Yardville-Allentown Road, After. Water-Bound Macadam; Surface Oil.

The gravel of which the road was built was spread to a width of from sixteen to eighteen feet, and the entire roadway was graded to a width of thirty feet.

The value of this improvement is well attested by the almost constant, continuous traffic passing over it.

* Chief Engineer for the York Highway Commission, Toronto, Ont.

Width of gravel-bed, 16 and 18 feet.
Width of gravel shoulders, 6 feet.
Length of gravel-bed, 13,809 feet.
Depth of gravel-bed, 8 inches.
Depth or gravel shoulders, 4 inches.

Gravel (A), 6,081 cubic yards, at $2.25; total..	$13,682.25
Gravel shoulders (B), 1,729 cubic yards, at $2.25; total	3,890.25
Earth excavation (A), 10,944 cubic yards, at 25 cents; total	2,736.00
Earth excavation (B), 1,164 cubic yards, at 25 cents; total	291.00
Drain, 4,000 lineal feet, at 12 cents; total	480.00
12-inch pipe relaid, 425 lineal feet, at 8 cents; total	34.00
Total	$21,113.50
Less difference between items and lump sum	113.50
Total	$21,000.00
Supervisor's salary	606.00
Engineering expenses	630.00
Extras, 371 cubic yards excavation, at 25 cents; total	92.75
Total cost of road	$22,328.75
Maximum grade before	3.25 per cent.
Maximum grade after	2.75 per cent.

Although there are less than a quarter of a million square yards of asphaltic concrete used, yet, because of its long life and its dustless surface, asphalt concrete will be more largely used in the future. In Union county 1.5 miles was laid.

The pavement is sixteen feet wide while the road is graded to a width of from thirty-three to thirty-six feet.

Width of stone-bed, 16 feet.
Length of stone-bed, 8,362 feet.
Depth of stone-bed, 7 inches.

Cedar Avenue and Monmouth Boulevard, Gravel, Before.

Amiesite, 15,715.1 square yards, at $1.29; total..	$20,272.48
Macadam at driveways, 680.3 square yards, at 55 cents; total	374.17
Earth excavation, 16,460.2 cubic yards, at 35 cents; total	5,761.07
Cobble stone gutters, 252.8 square yards, at 60 cents; total	151.68
Total	$26,559.40
Supervisor's salary	321.00
Extras, paid by county, relaying pipe and moving stone pile	85.12
Total cost of road	$26,965.52
Maximum grade before	8½ per cent.
Maximum grade after	5.24 per cent

Cedar Avenue and Monmouth Boulevard, Gravel, After.

This pavement was laid under the following specifications:—

All pavements which are composed of a mineral aggregate held together with a bituminous cement, and are mixed without heating the mineral aggregate, and laid while cold, must conform to the following additional requirements:—

Pavements of this type must be prepared from bituminous cements.....and may be laid either in one or two courses. When laid in two courses the bottom course must not be less than 1½ inches thick after ultimate compression and contain not over 30 per cent. of material which will pass openings one-half inch in diameter. This course of stone must be uniformly coated with sufficient asphalt to bind it firmly together. It must be laid and rolled to the proper grade and curvature before the top course is applied.

The top course must not contain any material which will not pass openings three-quarter-inch in diameter. It must contain not less than five per cent., nor more than nine per cent., by weight, of bitumen soluble in cold carbon bisulphide; the exact amount to be determined between these limits by the State Department of Public Roads.

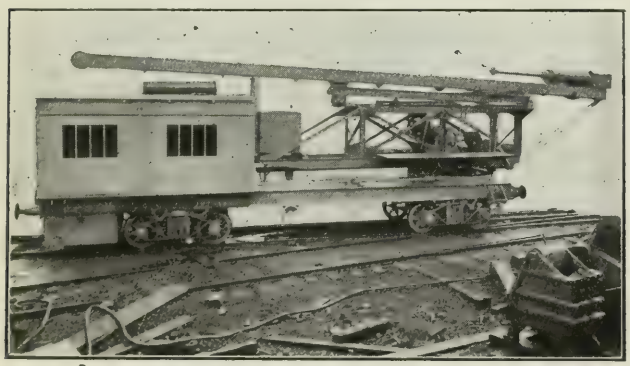
After the bottom course has been spread, it must be protected from all travel and kept free from dust or dirt until the top course has been spread and rolled into place or sealed in the manner specified hereinbelow. If the bottom course gets wet after being spread, it must be allowed to dry out before being rolled or covered with the top course. When dry it must always be covered with the top course at once, after being properly rolled, and in no case shall the bottom course be spread over three hundred feet in advance of the top course, nor shall over fifty feet be left uncovered during the night.

When pavements of this type are laid in one course, they will be sealed by painting the surface with a squegee coat of hot bituminous cement, when required by the State Department of Public Roads. This cement must be the same used in preparing the pavement, and must be applied at a temperature between 135° C. to 180° C. by a distributor which has been approved by the State Department of Public Roads. Immediately after this coat of bitumen has been spread, and while the same is yet hot, sand, fine clean gravel or screenings, or a mixture thereof, shall be spread over its surface and rolled at once.

These three classes of pavements give a good idea of the standards adopted by the New Jersey Commissioner of Public Roads, also of their costs.

A SELF-PROPELLED STEAM PILE-DRIVER.

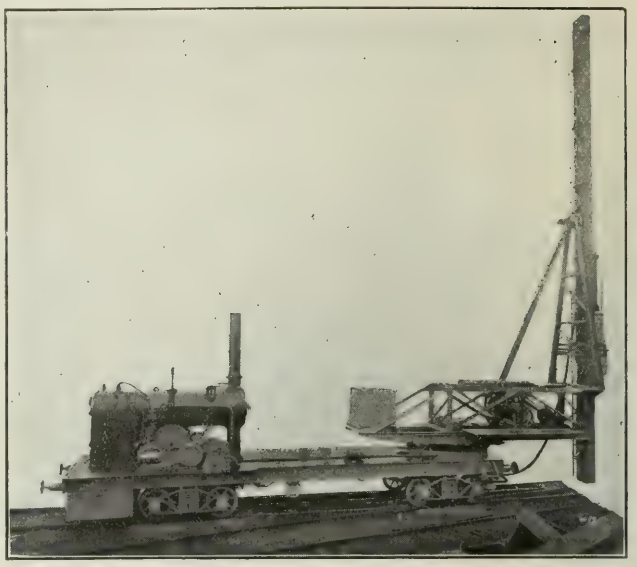
The photographs illustrate a locomotive steam pile-driving plant which has lately been completed by Messrs. Whitaker Brothers, Limited, of Horsforth, near Leeds, England, for service on the 5 ft. 6 in. gauge lines of the Central Argentine Railway. The equipment is claimed to be one of the largest and most complete machines of its kind ever constructed. It consists principally of a swivelling pile-driving frame with engine, boiler, winch, and all gearing and accessories mounted on a carriage running on two four-wheeled diamond-framed bogies. The machine is designed for driving piles up to 40 ft. in length and the pile-driving frame consists of a trussed steel beam, with a balance box at one end and short vertical struts at the other end, to the top of which the leaders are pivoted. The method of fixing the latter is such that piles may be driven on the latter up to 3 in. per foot, or the leaders may be hinged backwards into a horizontal position to clear the running gauge when the machine is traveling. The trussed beam is carried in roller guides and is mounted on a turntable, which allows the pile-driving frame to be moved backwards or forwards and rotate in either direction, so that the piles may be driven at distances varying between 7 ft. and 16 ft. in advance of the leading axle and at any distance up to 18 ft. on either side.



View of Pile-Driver Ready for Moving.

The turntable carrying the pile-driving frame is placed over the centre of the leading bogie and the boiler, engines and gearing are situated at the other end of the carriage, the hoisting ropes for the monkey and pile leading up to the frame through the centre of the turntable. The engines and boiler are rigidly mounted on the carriage platform, and are enclosed in a timber house fitted with sliding doors at each side and a small hinged door in front for giving access to the platform.

The traveling motion is of specially flexible type, so that the drive is unaffected by the extension or compression of the springs. Both axles of one bogie are driven by means of steel gearing and universal joints, and means are provided for disconnecting the traveling mechanism when the machine is required to be hauled by train. The bogies, wheels, axles, draw gear, and brakes are all made to the railway company's standards.



View of Pile-Driver Ready for Work.

The engines are of a special type, being totally enclosed with the working parts running in oil. The cylinders are fitted with a radial reversing motion, and gear is provided for performing the several functions, namely, propelling the machine, raising lowering the leaders, and hoisting the piles and monkey. The boiler is of the locomotive type, and is designed for a working pressure of 110 lb. per square inch. When the leaders are lowered the machine clears the company's construction gauge for rolling stock. A special hand winch is fitted on the pile-driving frame so that piles can be dealt with in the event of any part of the motive mechanism being temporarily out of order, while the slewing gear can also be disconnected and worked by manual labor. The 50 cwt. steam monkey is one of Whitaker Brothers' latest pattern and is capable of delivering from 40 to 60 blows a minute.

EDWARD PARTINGTON PULP AND PAPER COMPANY.

One of the largest business transactions in the history of New Brunswick was closed when deeds for the property of the Gibson Lumber Company were transferred to the Edward Partington Pulp and Paper Company, Limited, while the amount involved is said to be over two million dollars.

The property includes extensive lumber limits and licenses as well as mills, logs and lumber.

The Consolidated Pulp and Paper Company, through Senator N. M. Jones, of Bangor, Maine, had been negotiating to take over both the Gibson and Partington properties, but this has been abandoned, and Mr. Jones will now be associated with the Partington Company as manager of their pulp interests.

The capacity of the St. John pulp mill will be enlarged, and the establishment of another huge pulp mill on Nashwaak River, near Fredericton, will be considered.

WATER AND SEWERAGE SYSTEMS.*

By C. H. Altham.†

The development of modern waterworks began in Paris and London as early as the beginning of the 17th century, but little progress was made until the application of steam to pumping engines, first made in London in 1761. Since 1800 the development has been very rapid, both in Europe and America.

The first works in America for the supply of water to towns were those of Boston, built in 1652. Machinery was first used for pumping water at Bethlehem, Pennsylvania, where the works were put into operation in 1754. The first use of the steam engine was at Philadelphia in 1800, and in New York steam was applied in 1804. The principal development in this country has taken place since 1880, about 98% of all existing works having been constructed since that time. Nearly all towns of 2,000 inhabitants or more now have a public water supply, and the construction of works is progressing rapidly in many smaller towns and villages. While there is more work yet to be done in this direction, the chief work of the future will be in providing increased supplies for the rapidly growing cities and towns of this country, in developing new and better sources of supply and in the improvement of the quality of the existing supplies. There is also much opportunity for the engineer in the management of waterworks, in the direction of reducing cost of operation, prevention of waste and in the improvement of service in many other ways.

The most important use of a public water supply is that of furnishing a suitable water for domestic purposes. For such use the prime requisite is that the water should be pure. The transmission of certain diseases such as cholera and typhoid fever by polluted water is now universally recognized, and the value to the city of a pure supply when compared to one constantly polluted by sewage can scarcely be over estimated.

Another highly important function of a water supply is that of furnishing the necessary flushing water for a sanitary system of drainage. The most satisfactory and economical method yet found for disposing of the organic wastes of a community is by the water carriage system.

Besides furnishing an improved supply from the sanitary standpoint, a public works may often be made to furnish a water which for other reasons will be of greatly increased value to the domestic consumer; such as soft water in place of a hard well water,—a point of very considerable importance to both domestic and commercial users.

A good water supply is also of great value to the manufacturing interests of a town. Many establishments, such as sugar refineries, starch factories, cleaning and dyeing houses, chemical works, etc., require an abundant water supply, and in some cases water of a high degree of purity. The question of water supply indeed often determines the location of factories. Large quantities are also used for operating elevators, for boiler purposes, and for many other uses that may be classed as commercial.

The most important public use of water supply is in extinguishing fires. The economic value of a good fire-protection system is directly shown in the reduced rates of insurance which follow its introduction or improvement. Instead of distributing a heapy fire loss among the people of a community through high rates of insurance it is assuredly much better economy to distribute to the maintenance of a public water-works, which at the same time provides a suitable water for other purposes. To permit of the establishment of a certain class of factories it is absolutely essential that an efficient fire protection be furnished.

Other important public uses of a water supply are in street sprinkling and sewer flushing, in furnishing water for public buildings and for drinking and ornamental fountains. A real value exists in the improved appearance which may be given to a city by the use of water in fountains and for lawns and public parks; and, indeed, all the benefits accruing from a good water supply act indirectly to increase the desirability of a town for many purposes and to enhance the value of the property therein.

I do not intend to quote a lot of uninteresting statistics as to consumption, etc., but one thing does interest us and that is a good and pure source of supply. Our province is fortunate in possessing many beautiful streams of water and many, that besides furnishing water for public use, will be developed for power purposes. As the country is not densely populated the problems of pollution are not difficult, but as the population increases we shall be confronted with some of the difficulties that have and are being experienced by the large cities of the United States and Canada. The greatest objection to our water supply from the rivers is the turbidity of the water during the spring months and while the water may not be injurious it does not look very palatable, and I consider that the water supply for a town cannot be considered complete without an efficient filtration plant, as a plentiful and pure supply of water is an absolute necessity for the health and safety of the town.

Sanitary or Combined Sewers.—About equal in importance with a good water supply is the sewerage system, the sewer being the carrier for all the waste liquids and foul matter from the town.

Modern sanitary engineering especially as regards sewerage and drainage has had almost its entire development since 1850. It was not until 1873 that there was published a comprehensive treatise on sewerage, at about this time also much attention began to be paid in England to sewage purification. It was reserved, however, for America to put sewage purification on the road to a satisfactory scientific solution by the thorough investigations of the Massachusetts State Board of Health, began in 1887 and still under way. In America much was done in the third quarter of the 19th century to advance sewerage engineering through the studies of able engineers in connection with the design of systems for Chicago and other large American cities. About 1880 the separate system of sewage came strongly into prominence in America as advocated by the late Col. Geo. F. Waring and the construction of the Memphis sewers on this system at that time together with their great success in putting a stop to the fearful epidemics, which had so often desolated that city, did much to make sewerage possible for small cities. At present sewers have become so common and so necessary in modern life that towns of 2,000 population or even less are very generally taking up their construction. With the present wide adoption of sewers even by small communities, sewage disposal has come to be of very great importance and is now undergoing great development. Many discoveries remain to be made in this line in which the guiding principles have not yet been so thoroughly worked out as in the construction and maintenance of sewers themselves. The importance and value of the construction of sanitary engineering can hardly be exaggerated, upon them absolutely depends the health of every city. In this connection it should be said that pure water supply and good sewerage are both essential, and that it is impossible to separate the value of one from that of the other. A polluted water supply may

*Read at Union of Alberta Municipalities Convention in Macleod.

†Superintendent of Water and Light for the Town of Macleod.

spread the disease no matter how perfect the sewerage and an abundant water supply is essential to the proper working of sewers. On the other hand without sewers and drains, an abundant water supply serves as a vehicle to enable filth to saturate more deeply and more completely the soil under a city. Cess pools being very dangerous and objectionable for this reason. In addition to direct prevention of communication of disease by unsanitary conditions, modern sewerage facilities are so great a convenience that this advantage alone is usually more than worth the cost, this is shown by the increased selling and rental value of premises supplied with sewerage facilities. No sooner is a partial or complete sewerage system constructed in a town than prospective buyers or renters begin to discriminate severely against property not supplied with modern sanitary conveniences, and persons looking for new locations for business ventures or residence purposes discriminate in like manner in favor of towns having good sewerage.

From these few remarks it seems convincing that no town can afford to economize on the expense of making the water and sewerage systems as perfect as possible, they being so vital to the health and comfort of every inhabitant in a town.

STANDARDIZING OF TELEGRAPH BLANKS, BUSINESS CARDS AND CATALOGUES.

By Carl J. Printz.*

Business correspondence is now invariably made on sheets 8½" × 11", the so-called letter size, regardless of whether the letter is a long one or a short one, and up-to-date firms have also adopted this size for their specifications and tenders. This is done, of course, for the convenience of filing, as it is very hard, in any filing system, to file the "pap" size or to look through a file containing a variety of sizes.

The telegraph companies are slow in adopting the 8½" × 11" size for their blanks, and the reason for this is probably that they have their filing cabinets made for their usual size, but a change to letter size would be exceedingly welcomed by all business concerns, and it will undoubtedly come sooner or later.

As to business cards a standardization is highly desirable and the 3" × 5" size is gradually adopted by persons who use their cards for other purpose than simply an introduction. Business cards are continually referred to by purchasing agents and others as they, in a majority of cases, are substitutes for catalogues, and are much easier filed and looked over —if printed on some standard size.

The 3" × 5" is a convenient size for the vest pocket and it fits any standard filing case.

As business cards of this size generally have descriptive matter printed on both sides, it would be inconvenient to have them locked with the locking-rod in the card case, but as a card with perforations or cut for such locking device will suggest filing, it is found advantageous, and it also distinguishes such cards from the small blotters which are distributed as advertisements.

Catalogues are among the hardest things to file on account of their extreme variety in size and thickness, but even in this line there is a growing tendency to standardizing, and the 8½" × 11" seems to take the lead and will, no doubt, some day be generally adopted.

*Consulting Engineer, Toronto.

THE DISPOSAL OF TORONTO SEWAGE.

The question of the pollution of the Great Lakes is assuming more and more importance. From repeated analyses made during the past few years the amount of chlorine in the lakes appeared to be on the increase. The Board of Water Experts, who have just presented their report on the question of water supply for Toronto, state that if sewage pollution is not stopped or minimized it will in time render the westerly end of Lake Ontario unsafe for use as a public water supply. The Board's comments on the disposal of Toronto sewage are of interest in this connection. The following is abstracted from their report:—

The question of the disposal of the sewage of Toronto has such a close connection with the question of water supply, that it has demanded close investigation by this Board. Present conditions and proposals have been investigated, the results of which are hereto appended. The conclusions of this Board upon the investigation are herewith given:—

Assuming the Toronto sewage to contain 300 parts of dry residue solids per 1,000,000, then a dry weather flow of 45,000,000 gallons per day will represent approximately 60 tons of dry residue solid matter, or 3,000 lbs. per 1,000,000 gallons of sewage.

The amount of solids which will be primarily arrested by the screens will be insignificant.

At Providence, R.I., with gratings 1 inch apart, 41 lbs. per million gallons were retained. At Boston, with similar gratings, the rate was 300 lbs. With gratings .75 inch apart the average rate of retention at the South Metropolitan System for the years 1905-1908 was 324 lbs. At the London Northern outfall sewer in 1897, with similar gratings, 243 lbs. At Berlin, with bars spaced 0.6 inch apart, 212 lbs. were retained.

It can not be assumed that the screening apparatus as proposed for Toronto sewage will remove more than 100 lbs. of dry solid residue per 1,000,000 gallons of sewage. This leaves 2,900 lbs. per 1,000,000 gallons to be removed by sedimentation. Assuming an optimistic conclusion that 30 per cent. of the solids will be removed by sedimentation, then 2,030 lbs. of dry residue per 1,000,000 gallons will continue to enter the lake. This means that approximately 40 tons per day of dry residue will continue to enter the lake after treatment at dry weather flow.

The effluent out-take is to be 60 inches in diameter laid across and under the east end of Ashbridge's Bay for a distance of about 1,830 feet from the tank to the lake shore, and continued into the lake for a further distance of about 3,500 feet, finishing at a point of discharge in about 20 feet depth of water. This point of discharge will be located approximately 26 000 feet (or about 5 miles) to the east of the present water intake mouth, and approximately 24,000 feet (or about 4½ miles) west of the "Dutch Church" at Scarboro' Cliffs.

The total length of the effluent out-take is 5,330 feet. With the lake level at 40 and the tank level of sewage at 51, representing the height of sewage in the inlet channel at three times the dry weather flow, a hydrostatic head of 11 feet is effected, allowing of a maximum discharge of 100 cubic feet of sewage per second, or 1.2 times the dry weather flow at 45,000,000 gallons per day.

It is, therefore, apparent that under the above conditions, while 135,000,000 gallons of sewage are entering the works, only 54,000,000 gallons can be treated, while the balance of 81,000,000 gallons must be dammed back and pass over and through the storm overflow provided at the works direct into Ashbridge's Bay immediately south of the tanks.

It is only when the tanks are taking the dry weather flow at 83 cubic feet per second, with the sewage standing at an elevation of 47.50 in the inlet channel, that equilibrium is

reached and that the effluent out-take is discharging an equal amount of sewage to that which is entering. Any increase in discharging can only be effected by backing up and increasing the head on the effluent out-take and thus increasing velocities and so deleteriously affecting the process of sedimentation.

The general conclusions which may be arrived at from the above statement are as follows:—

(a) That four times the dry weather flow of sewage (taken at 45,000,000 gallons per day, dry weather flow), will arrive at the sewage works.

(b) That the amount of sewage over and above four times the dry weather flow is variable and may reach 22 times the dry weather flow at a rainfall rate of 1.5 inches per hour. That 0.10 of an inch rainfall per hour will produce 5.2 times the dry weather flow. That a storm such as occurred on 27th August, 1911, will produce 60 times the dry weather flow. That for 400 hours of an average year the rainfall will reach or exceed 5.2 times the dry weather flow.

(c) That the sewage of Toronto normally contains about 3,000 lbs. of dry residue solid matter per each 1,000,000 gallons of sewage. That 100 lbs. of these solids will be retained by screening. That a further 870 lbs. will be retained by sedimentation. That 2,030 lbs of solids in comparatively finer particles than that which is retained will continue to enter the lake, or that 60 tons of dry residue matter per day is contained in normal Toronto sewage, and that 40 tons will continue per day to enter the lake at a point 3,500 feet from shore, about midway between the "Dutch" Church and the existing water intake pipe.

(d) That an optimistic view of the capacity of the tanks is that they are only equal to a dry weather flow of 45,000,000 gallons, and that even with this capacity and rate of flow, only 30 per cent. of the solid matter and only the grosser solids will be retained.

With respect to the effect the proposed intercepting sewers and disposal works will have on Lake Ontario water as a source of domestic supply in the neighborhood of Toronto, it must be at once conceded that it is out of the question to anticipate any greater purity of water for a radius of ten miles from the City Hall than has existed heretofore. The continued discharge of storm water by means of the present sewer outlets, the discharge of sewage treated only to the extent of a small proportion of the grosser solids direct into the lake five miles from the water intake, without any attempt to reduce and extinguish the cause of disease infection, will reduce the present nuisance to Toronto Bay and immediate shore neighborhood, but, on the other hand, such will in no way tend to bring about a class of water within ten miles' radius of the city suitable for domestic consumption, unless such water undergoes some efficient process of purification treatment capable of destroying the disease infection due to sewage pollution.

It is now generally conceded that all methods of sewage disposal such as screening, sedimentation and filtration, may remove nuisances which are due to the decomposition of organic matters, that is, nuisances which are apparent to the senses, but that such processes do not entirely and only to a very small extent remove the causes of disease infection peculiar to sewage discharges. In order to render sewage discharges pathogenically harmless, it is necessary that such be disinfected if discharged into a water used as a source of domestic supply.

It is an undoubted fact that dilution of sewage with water tends to its ultimate organic purity and that large bodies of water are capable of dealing with and purifying large quantities of organic matter; on the other hand the causes of disease infection are not so readily acted upon and may be carried for considerable distances. It must, therefore, be concluded that considering the present proposal of the city regarding sewage treatment, the present acknowledged contaminated character of the lake water in the vicinity of Toronto must remain the chief factor in reference to water supply.

IMPORTATION OF CEMENT.

In connection with the tariff reduction on cement, it will be interesting to see how the duty which has heretofore prevailed against United States cement was made up.

Barrels of 350 lbs., at 12½c. per 100 lbs.	.43¾
Bags valued at 40c. per (bbl.) at 20%	.08
Total duty per barrel against American cement	.51¾

Inasmuch as the government has concluded, for the time being at least, to reduce the duty 50 per cent., this would mean that 26c. per barrel will be reduced. Assuming that the price of United States cement at the factory is 60c. per barrel, and that the freight rate is 48c., we would have the following:—

American price per barrel at mill	.60
Freight	.48
Duty	.26
Total price	1.34

So far as the Montreal market is concerned, it would seem that this would have little effect, inasmuch as cement has been quoted here at the factory at 1.35 to 1.45, exclusive of package, and it is much more convenient to purchase from manufacturers on the spot than abroad. It is just possible, however, that the lowering of the duty to 26c. would mean the importation of British cement to some extent, inasmuch as the preferential would reduce this by one-third, which would mean about 17c. as against 34, which has prevailed up to the present.

It seems not unlikely also that 60c. at the factory in the United States is an exceptionally low quotation. Some quotations are 65c., and it is the opinion of many manufacturers that with the additional demand which the lowering of the duty may bring about, United States manufacturers may be able to ask a yet further advance. This, however, may be doubted, as the over-production in the United States is great.

NEW HEALTH OFFICERS IN ONTARIO.

Six of the seven district health officers have been appointed by the Provincial Government. They are:—Dr. D. B. BENTLEY, of Sarnia, for the district comprising Essex, Elgin, Kent, Lambton, Middlesex and Oxford; Dr. T. J. McNALLY, of Owen Sound, for the district comprising Bruce, Dufferin, Grey, Huron, Perth, Wellington and Waterloo; Dr. D. A. McCLENAHAN, of Waterdown, for the district comprising Brant, Haldimand, Halton, Lincoln, Norfolk, Peel, Welland, Wentworth, and York; Dr. GEO. CLINTON, of Belleville, for the district comprising Ontario, Durham, Northumberland, Prince Edward, Hastings, Peterboro', Victoria, Muskoka and Simcoe; Dr. P. J. MOLONEY, of Cornwall, for the district comprising Lennox and Addington, Frontenac, Leeds, Grenville, Stormont, Dundas, Glengarry, Prescott, Russell, Carleton, Lanark and Renfrew; Dr. R. E. WODEHOUSE, of Fort William, for the district comprising the districts of Manitoulin, Algoma, Kenora, Thunder Bay and Rainy River. The officer for the remaining district, comprising the districts of Parry Sound, Nipissing, Temiskaming and Sudbury, has not been named.

The appointments take effect on August 1st, when the doctors report for the prescribed course of study at the University.

PERSONAL.

MR. J. DARLINGTON WHITMORE, after a residence of nine years in Canada, principally spent in the West, passed through Toronto this week on his way to New Zealand.

MR. J. McD. PATTON, who this spring completed his post-graduate year for degree of B.A.Sc., at the University of Toronto, was recently appointed superintendent of waterworks for the city of Regina.

MR. JOHN MacDONALD, formerly a member of the engineering staff of the city of Medicine Hat, has been appointed district engineer for the district of Medicine Hat and Milk River, by the government of the province of Alberta.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithaca, N.Y.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN FORESTRY ASSOCIATION.—Convention will be held in Victoria, B.C., Sept. 4th-6th. Secy., James Lawler, Canadian Building, Ottawa.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Annual Assembly will be held at Ottawa, in the Public Library, on 7th October, 1912. Hon. Sec'y, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. · Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President, J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Jas. Anderson, Gen. Mgr., Sandwich, Windsor and Amherst Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
6-17—Electric Generating Station Equipment, Bassano, Alta.	(S.)	5-30
7-3—Storm Drain, Orillia, Ont.	(P. & S.)	6-20
7-1—Boilers, 300-h.p., Verdun, Que.	(S.)	6-20

(Bassano specifications also on file at the office of The Canadian Engineer, Montreal, and the Engineers, Messrs. Bowring & Logan, 322 Donald St., Winnipeg).

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Arden, Man., bridge	July 3.	June 13.	78
Barrie, Ont., public buildings	June 27.	June 13.	67
Boswell, B.C., pile bent wharf	July 2.	June 6.	68
Carr's Brook, N.S., breakwater wharf	June 27.	June 6.	68
Gananoque, Ont., drill hall	June 22.	June 6.	68
Humb ldt, Sask., fittings in post office, etc.	June 24.	June 13.	68
Fort William, Ont., sewer	July 5.	June 13.	67
Kerrisdale, B.C., steel pipes	June 24.	June 6.	67
Kerrisdale, B.C., valves, castings and hydrants	June 24.	June 13.	67
Oshawa, Ont., sidewalks	June 19.	June 13.	78
Ottawa, Ont., mail contract	June 21.	May 23.	76
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., sale of steamer	July 3.	June 6.	78
Ottawa, Ont., design and construction of steamship	June 30.	May 16.	76
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Port Arthur, Ont., paving	June 24.	June 6.	80
Point Edward, Ont., operating house	July 1.	June 13.	68
Quebec, Que., leasing of water-powers	June 26.	May 2.	72
Regina, Sask., Torhill reservoir	June 21.	June 6.	78
St. Catharines, Ont., trunk sewer	July 3.	June 13.	80
Saskatoon, Sask., garbage incinerator	June 25.	May 2.	74
Tete de Point Barracks, Ont., stables	June 23.	June 13.	67
Toronto, Ont., high level interceptor	July 2.	June 13.	80
Vancouver, B.C., bridge construction	July 8.	May 30.	74

TENDERS.

Calgary, Alta.—Tenders for one 500 K.W. synchronous motor generator, to be delivered, erected and installed in the city, will be received up to noon of June 26th, 1912, by the City Commissioners. Specifications may be obtained from the Commissioners' office. J. M. Miller, City Clerk.

Carleton Place, Ont.—Tenders will be received by the Sewers and Water Commission of the municipality of Carleton Place, Ont., up to noon of July 1st, 1912, for the construction and supply of all materials in connection with about five miles of sewers and about five miles of watermains. Consulting Engineer, T. Aird Murray, Toronto; Resident Engineer, B. G. Michel, Carleton Place, Ont. (See advertisement in The Canadian Engineer of June 27th.)

Fort William, Ont.—Tenders for the construction of a concrete and tile sewer on Marks Street, will be received at the office of the City Clerk, until July 5th, 1912. Plans, etc., can be obtained at the office of John Wilson, City Engineer.

Kingston, Ont.—The Board of Works are calling for tenders for asphaltic block pavements to be laid on a number of streets in the city.

London, Ont.—Tenders for the construction of about 900 feet of concrete breakwater on the Medway River. Specifications, etc., at the office of F. W. Farncomb, Consulting Engineer, London. (See advt. in Canadian Engineer.)

Moose Jaw, Sask.—Tenders for the supply of material and erection of City Hall Annex will be received by the City Commissioners, Moose Jaw, up to noon of June 20th, 1912.

Napanee, Ont.—Tenders for the completion of about 10,000 lineal feet of tile sewers with manholes and junctions, will be received until noon of June 25th, 1912. Sewers to be constructed of 9 in., 12 in., and 15 in. standard vitrified sewer pipe. Plans and specifications may be seen at the office of the engineer, George C. Wright, Kingston, Ont. W. A. Grange, town clerk, Napanee, Ont.

Norwood, Ont.—The Department of Militia and Defence, Ottawa, is open to receive tenders for the construction of a new Drill Hall at Norwood, until July 3rd. Specifications may be seen at the offices of the Officer Commanding 3rd Division, Kingston, Ont.; Officer Commanding "E" Company, 40th Regiment, Norwood, Ont., and the Director of Engineer Services, Headquarters, Ottawa.

Orillia, Ont.—Tenders for the construction of approximately 16,200 lineal feet of sanitary sewers will be received until July 3rd, 1912. Plans, etc., on file in the Town Engineer's office, Orillia. (See advt. in The Canadian Engineer).

Orillia, Ont.—Tenders for the construction of approximately 2,450 lineal feet of reinforced concrete box storm drain and sidewalk top, will be received until July 3rd, 1912. Plans and specifications on file at the office of The Canadian Engineer, 62 Church St., Toronto, and at the Town Engineer's office, Orillia. (See advt. in The Canadian Engineer).

Ottawa, Ont.—Tenders will be received until June 25th, 1912, for a boom dredge required for the Rideau Canal. Plans, etc., can be obtained on application to L. K. Jones, secretary, Department of Railways and Canals, Ottawa.

Ottawa, Ont.—Tenders for the construction of fittings, finish, etc., at the Armoury, Niagara Falls, Ont., will be received until June 25th, 1912. Plans, etc., can be obtained on application to Mr. Geo. Seales, Clerk of Works, New Armoury, Niagara Falls, Ont., and at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders for certain alterations and additions to the Elkhorn Industrial School Buildings, will be received up to noon of July 9th, 1912. Plans and specifications may be seen at the Indian Office, Winnipeg; at the School, Elkhorn, and at the Postoffices at Brandon and Virden. J. D. McLean, Assistant Deputy and Secretary, Department of Indian Affairs, Ottawa.

Ottawa, Ont.—Tenders will be received until noon of June 22nd, 1912, for repairs to the Rifle Range at Pointe aux Trembles, P.Q. Plans and specifications may be seen at the offices of the Officer Commanding the 4th Division, Montreal, P.Q., and the Director of Engineer Services, Headquarters, Ottawa. Eugene Fiset, Col., Deputy-Minister, Department of of Militia and Defence, Ottawa.

Ottawa, Ont.—Tenders for the construction of two 95 cubic yards' capacity wooden hopper scows, will be received until July 3rd, 1912. Plans, etc., at the Department of Public Works, Ottawa; offices of G. G. Scovil, Esq., Superintendent of Dredges, St. John, N.B.; G. M. Graham, Esq., Superintendent of Dredges, New Glasgow, N.S.; and J. N. McDonald, Esq., Superintendent of Dredges, Charlottetown, P.E.I. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received at the Department of Public Works, Ottawa, until July 4th, 1912, for the construction of a wharf at Brundage's Point, Westfield, King's County, N.B. Plans and specifications to be seen on application to J. K. Scammell, Esq., District Engineer, Chatham, N.B., and at the Department of Public Works, Ottawa.

Ottawa, Ont.—The Department of Railways and Canals, Ottawa, will receive tenders until August 1st, 1912, for the construction of the section of the Hudson Bay Railway from Thicket Portage to Split Lake Junction. Plans, etc., at the office of the Chief Engineer of the Department of Railways and Canals, Ottawa, and at the office of the Chief Engineer of the Hudson Bay Railway, Winnipeg.

Ottawa, Ont.—Tenders for dredging required at Port Arthur, Ont., will be received until July 2nd, 1912. Full particulars can be obtained on application to R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—The Department of Public Works, Ottawa, is open to receive tenders until July 10th, 1912, for the construction of a wharf at Cache Bay, District of Nipissing, Ont. Plans, etc., at the Department, and at the office of J. G. Sing, Esq., District Engineer, Confederation Life Building, Toronto, and on application to the Postmaster at Cache Bay, Ont.

Ottawa, Ont.—The Department of Public Works are calling for tenders for dredging required at Perry Point, N.B., tenders to be received until June 26th, 1912. Combined specifications and form of tender can be obtained on application to the Secretary, R. C. Desrochers, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders are invited for the construction of quarantine buildings upon the quarantine grounds at Windsor, Ont. Tenders to be in Ottawa by noon, July 8th. Particulars may be obtained either from Inspector F. A. Jones, Windsor, or from the Acting Veterinary Director General, Ottawa. A. L. Jarvis, Asst. Dep. Minister and Secretary of Agriculture, Dept. of Agriculture, Ottawa.

Ottawa, Ont.—The Department of Indian Affairs will receive tenders up to noon of July 12th, 1912, for alterations, etc., at Indian boarding school buildings at Fort Frances, Sandy Bar and Fort Alexander. Plans, etc., at the Indian Offices, at Winnipeg and Selkirk, and at the offices of the Indian Agents at Kenora and Port Arthur.

Ottawa, Ont.—The Department of Militia and Defence will receive tenders up to noon of July 2, 1912, for the construction of a new Drill Hall at Omemee, Ont. Specifications may be seen at the offices of the Officer Commanding 3rd Division, Kingston, Ont.; Officer Commanding "D" Company, 46th Regiment, Omemee, Ont., and the Director of Engineer Services, Headquarters, Ottawa.

Ottawa, Ont.—The Department of Railways and Canals, Ottawa, will receive tenders until August 1st, 1912, for the construction of the section of the Hudson Bay Railway from Thicket Portage to Split Lake Junction. Plans, etc., at the office of the Chief Engineer of the Department of Railways and Canals, Ottawa, and at the office of the Chief Engineer of the Hudson Bay Railway, Winnipeg. (See advt. in Canadian Engineer.)

Ottawa, Ont.—Tenders for the erection of an operating house and double dwelling, at Alert Bay, at Cormorant Island, B.C., will be received until noon of July 1st, 1912. Plans, etc., at the office of the Superintendent of Radio-Telegraph Branch of Department of Naval Service, Ottawa, or at the office of the District Superintendent or Radio-Telegraph Service, Victoria, B.C., and office of the Postmaster at Alert Bay, Cormorant Island, B.C. G. J. Desbarats, Dep. Min., Dept. of Naval Service, Ottawa.

Regina, Sask.—Tenders will be received until June 21st, 1912, for the following:—

(1) Two reinforced concrete bridge abutments for a bridge over the Battle River, west of Battleford.

(2) Two reinforced concrete bridge abutments and two small reinforced concrete bridges west of Rosthern.

Plans, etc., may be obtained on application to A. J. McPherson, Chairman, Board of Highway Commissioners, Regina, Sask.

Saskatoon, Sask.—Plans have been filed and tenders are now being called for the new C.P.R. Building, which will involve an expenditure of over $200,000.

Shoal Lake, Man.—Tenders for the construction of a brick and stone municipal hall for the municipality of the village of Shoal Lake, will be received up to noon of June 25th. Plans, etc., at the office of the architect, Hooper and Hooper, 303 McIntyre Block, Winnipeg, or at the office of F. M. Dobbs, sec.-treas., municipality of village of Shoal Lake, Man.

Toronto, Ont.—Tenders will be received until noon of July 22, 1912, for the complete supply and installation of three hundred and seventy-one (371) opera chairs in St. Lawrence Hall, Toronto. Specifications, etc., at the offices of the Property Department, City Hall, Toronto. G. R. Geary (Mayor), chairman Board of Control, City Hall, Toronto.

Toronto, Ont.—Tenders for the construction of dairy barns to be erected on the grounds of the Ontario Agricultural College, Guelph, will be received up to noon of June 29th, 1912. Plans and specifications can be seen at the office of the Superintendent, Agricultural College, Guelph, and at the office of H. F. McNaughten, secretary Department of Public Works, Province of Ontario, Toronto.

Toronto, Ont.—Tenders for the laying and jointing of a 36-in. water main on Front Street, with connections, will be received up to noon of July 2nd, 1912. Specifications may be seen at the office of the Commissioner of Works, Toronto. G. R. Geary (Mayor), chairman, Board of Control, City Hall, Toronto.

Toronto, Ont.—Tenders for the laying and jointing of a 36-in. water main on Front Street, with connections, will be received up to noon of July 2nd, 1912. Specifications may be seen at the office of the Commissioner of Works, Toronto. G. R. Geary (Mayor), chairman, Board of Control, City Hall, Toronto.

Vancouver, B.C.—Competitive plans will be received up to noon, June 28th, 1912, for the proposed Georgia-Harris Viaduct. Specifications, plans and conditions of competition may be obtained at the office of the City Engineer, City Hall. Wm. McQueen, City Clerk, Vancouver, B.C.

Verdun, Quebec.—Tenders will be received at the Town Hall, Church Avenue, Verdun, until July 1st, 1912, for the supply and installation of two 300 horse-power water tube boilers. Specifications, etc., at the Town Engineer's office, Verdun, and also at the office of The Canadian Engineer, 62 Church Street, Toronto. (See advt. in The Canadian Engineer).

Winnipeg, Man.—Tenders for the manufacture and delivery f.o.b., Winnipeg, of approximately 70,000 duct feet of single vitrified clay conduit, will be received up to noon of June 21st, 1912. Full particulars may be obtained at the office of the City Light & Power Department, 54 King Street. M. Peterson, secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received until June 20th, for all the trades required in connection with the erection and completion of a fireproof office building, for the Great West Permanent Loan Company. J. H. G. Russell, architect, McArthur Building, Winnipeg.

CONTRACTS AWARDED.

Berlin, Ont.—The contract for the new school building was awarded to Mr. Henry Braniff, his tender being the lowest. The cost will be in the neighborhood of $23,000.

Cheticamp, N.S.—Dredging; contractors, Vivian T. Bartram, 117 Stair Building, Toronto.

Hamilton, Ont.—The Des Moines Manufacturing Company, of Des Moines, Iowa, have received the contract to construct a water tower to cost $4,990.

Hillsborough, N.B.—Post office fittings; the J. T. Schell Company, of Alexandria, Ont.

Barrett Specification Roofs

On the "Concrete City."

IN the illustration below, the Turner Construction Company of New York, has brought together in a scale drawing an accurate representation of most of the important modern concrete buildings which they have erected during the past nine years, at an approximate cost of $12,000,000.

It is an imposing display of best types of modern construction—"*a concrete city*" indeed—scientifically designed for maximum service at minimum cost and minimum maintenance.

It is significant that 95 per cent. of the entire roof area is covered with the Barrett Specification type of roofing. The figures are as follows:

Barrett Specification type of roofs	1,490,523 sq. feet
Plastic Roofings	14,714 sq. feet
Slate Roofings	21,640 sq. feet
Tile Roofings	5,619 sq. feet
Ready Roofings	38,381 sq. feet
Copper Roofings	6,355 sq. feet
All other kinds	7,448 sq. feet

It is important to remember that while all these buildings were constructed by the Turner Construction Company, the specifications were drawn by a large number of architects and engineers.

Barrett Specification Roofs were almost unanimously selected for one reason only, namely that they would give *better* service at *lower cost*, than any other roof covering.

Barrett Specification Roofs require no painting or similar attention—in other words, there are no maintenance costs. They will last upwards of 20 years without any care.

The superior economy of Barrett Specification Roofs justifies their adoption not only on big first-class concrete buildings, but on every flat roofed building from a tenement to a skyscraper—from a small mill to a modern manufacturing plant costing millions. But be sure it's a real Barrett Specification Roof. The only way to be sure is to incorporate The Barrett Specification in full in your plans.

Copy of The Barrett Specification free on request. Address our nearest office.

THE PATERSON MANUFACTURING CO., LIMITED

MONTREAL TORONTO WINNIPEG VANCOUVER ST. JOHN, N.B. HALIFAX, N.S.

Kenora, Ont.—Fire hall; Messrs. S. C. Sharman and F. Gilbert, of Kenora, Ont. Price, $20,875, which covers all trades except heating.

Lethbridge, Alta.—The tenders submitted for the construction of the car barn and sub-station for the street railway system were as follows: Hotson and Leader, $51,410; Lussier Construction Co., $39,931; Smith Bros. and Wilson, $39,100. The contract was awarded to the latter firm.

Maple Creek, Sask.—The contract for the 7,000 yards of cement sidewalks, has been awarded to Mr. C. H. Campbell, Cavallier, N.D., his price being 19c. per sq. foot for sidewalks and 37c. per lineal foot for curb.

Moose Jaw, Sask.—Sewer pipe and specials; the Saskatchewan Glass & Supply Co., Moose Jaw.

Nanaimo, B.C.—Interior fittings, post office; the Berlin Interior Hardwood Co., Ltd., of Berlin, Ont.

Oakville, Ont.—The contract for the building of the high level bridge over the creek at Cemetery Hill, near Oakville, has been awarded to Mr. A. J. Gibson, of Oakville.

Ottawa, Ont.—Additions and alterations to fuel testing building; contractor, A. G. Marshall, 5 O'Connor Street, Ottawa.

Port Arthur, Ont.—The contract for the Hill Street Fire Hall has been awarded to the Alberta Land Co. Price, $22,000. H. J. Powers, Engineer.

The contract for the twelve-room school on Prospect Avenue, has also been awarded to the Alberta Land Company. Price, $75,000.

Saskatoon, Sask.—Messrs. E. M. Joyl and Company have secured a contract to supply 170,000 ties to Messrs. McArthur and Boyd to be used on the Hudson Bay Railway.

Saskatoon, Sask.—Messrs. Hoge & Marr, have received a contract to construct a moving picture theatre on 20th Street East. Mr. P. L. Sommerfeld, civic alderman, is a member of the company.

Stratford, Ont.—At a meeting of the market and hall committee, the tender of Mr. William Daly, for the market shelter at $12,070, was accepted.

Ste. Therese de Blainville, Que.—The work of installing a waterworks system to cost $75,000 for the Aqueduct Company of Blainville, Blainville, Que., is being done by the owners of the company under the supervision of Engineers Ouimet and Lesage, St. Lawrence Boulevard.

Toronto, Ont.—Messrs. J. E. Webb Company, general contracting, have been awarded the contract for the masonry work for the American Hat Frame Company, to be built at the corner of Bathurst and Wellington Streets. Material used will be concrete, pressed brick and steel.

West Toronto, Ont.—Messrs. Orr Brothers have been awarded the contract for the construction of a retaining wall at Annette School. The cost of this work is placed at $7,125.

Winnipeg, Man.—The National Construction Company have been awarded the contract for the erection of the new law courts, their bid being $760,000.

Winnipeg, Man. — Messrs. Clayton Brothers are the builders and C. Bridgeman the architect for the erection of two large apartment blocks involving an outlay of $252,000.

LIGHT, HEAT AND POWER.

Brockville, Ont.—The municipal gas and light committee have recommended that a number of additional incandescent electric lamps be placed on certain street corners; many of these are to replace gas lamps now in use. Mr. J. H. Bryson is the engineer of Brockville.

Northern Canada.—Messrs. E. M. Joyl and Company have secured a contract to supply 170,000 ties to Messrs. McArthur and Boyd to be used on the Hudson Bay railway. The contract calls for delivery of the ties early next October at which time the railway contractors expect to be in a position to complete that part of the road which is now being graded.

Penticton, B.C.—The council of this municipality will call tenders on a 200 h.p. Deisel engine to be used as motive power in the lighting plant of the town.

Toronto, Ont.—If the approval of the Fire and Light Committee is shown the Hydro-Electric Department will put a few flaming arc lamps at the railway crossing on Bay Street.

Welland, Ont.—A report states that the estimate of the Hydro-Electric Commission for a lighting system for this municipality is given at $45,000, inclusive of cluster lights.

GARBAGE, SEWAGE AND WATER.

East Toronto, Ont.—The ratepayers in a portion of this section are petitioning for annexation and an extension of the municipal water system. They claim their wells have failed them.

Brockville, Ont.—The municipal fire and light committee have recommended that the mains in the vicinity of the James Smart Manufacturing Co. be extended and additional hydrants for fire protection be connected to the same. Mr. J. H. Bryson is the engineer of this municipality.

Saskatoon, Sask.—The new system of rapid water filtration has been given a try-out with complete satisfaction.

St. Thomas, Ont.—The City Engineer has reported on the cost of a proposed 20-inch steel water main from the water works to Balaclava Street. He estimates the cost of this work at $13,000. M. H. Baker, City Engineer.

Toronto, Ont.—Dr. Hastings, municipal Medical Health Officer, has reported on his requirements for the bacteriological treatment of the sewage effluent. He has been instructed to install two chlorinating plants. There is a probability of slow filtration beds being added to the equipment.

BUILDINGS AND INDUSTRIAL WORKS.

Berlin Ont.—The management of the W. G. & R. Shirt and Collar manufacturers will erect a new building during the coming season.

Berlin, Ont.—The municipal council have looked with favor on a proposed rubber manufactory. If this is proceeded with two five story buildings will be erected and 1,000 h.p. required from the Hydro-Electric Commission.

Guelph, Ont.—The Ontario Agricultural College officials will erect two new buildings during the coming season.

Edmonton, Alta.—Mr. Kenneth McLeod is having plans prepared for a nine story office building to cost $500,000. Mr. John T. Gow, of Spokane, is the architect for this work.

Montreal, P.Q.—The congregation of the Church of St. Irene will spend the sum of $125,000 on the construction of a new building. The Rev. Father Bereard is the rector of this parish and the architects are Messrs. McDuff and Lemieux.

Peterborough, Ont.—The Board of Trustees of the Nicholls Hospital have decided to erect two new buildings. One being 90 x 40 feet will provide accommodation for 45 beds the other will be used for laundry purposes.

Regina, Sask.—The municipal School Board will submit a by-law to the ratepayers calling for an issue of debentures of $275,000 to be used for school building purposes.

Saskatoon, Sask.—Messrs. Adams Bros.' Harness Company, Limited, of Toronto, are planning to erect a large building in this city. Mr. F. W. Adams, Winnipeg, may be addressed in the matter.

Saskatoon, Sask.—The management of the King George Hotel are preparing to erect a three story annex on 2nd Avenue.

Tormorden, Ont. — The congregation of St. Andrew's Church have approved plans for an addition to their building which will double the seating capacity. Mr. Fred. Smith is a member of the finance committee. Todmorden is near Toronto.

Toronto, Ont.—The Canadian National Exhibition has secured a permit to erect a $35,000 entrance to Exhibition Park, comprising pylons and gates.

Toronto Ont.—The Municipal Works Committee have adopted the so-called terrace route for the proposed Bloor Street viaduct, as favored by the special committee. The estimated cost is $2,221,760. It will cost $8,000 to make the necessary preliminary borings.

48 in. CONTINUOUS STAVE LINE.

Manufacturer of

Galvanized Wire Machine Banded

WOOD STAVE PIPE

CONTINUOUS STAVE PIPE

RESERVOIR TANKS

For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

Full particulars and estimates furnished.

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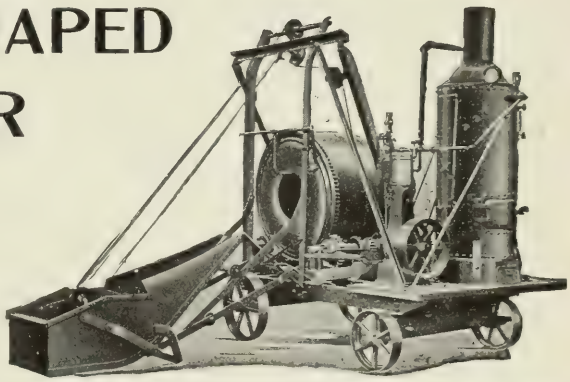
Factory: 1551 Granville Street, VANCOUVER, B.C. P.O. Box 563.

WETTLAUFER

HEART-SHAPED MIXER

Write for 1912 Catalogues.



A MIXER is not COMPLETE unless it is equipped with **AUTOMATIC HOPPER, AUTOMATIC POWER DUMPING DEVICES,** and built of **STEEL** and **SEMI-STEEL** as used in the entire construction of our mixers throughout.

The famous heart-shaped drum turns the batch end for end very quickly; this ensures positive mixture.

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WORKS AT MITCHELL, ONT. **TORONTO.** DETROIT, MICH. BUFFALO, N.Y.

A. R. WILLIAMS MACHY. CO.,
15 Dock Street,
St. John, N.B.

WETTLAUFER BROS.
316 Lagauchetiere St., W.,
Montreal, Que.

Toronto, Ont.—A Dominion Government purchasing agent has secured an option on property at the south-west corner of Saulter Street and Queen Street East. It is said that the property is wanted as a site for the new post office, which will cost about $200,000.

West Toronto, Ont.—The General Fire Extinguisher Company has taken out a permit for a two-story warehouse in Dundas Street near Chelsea Avenue. It will cost $40,000.

Wetaskiwin, Alta.—Construction work has been started on a new factory for the Vulcan Automobile Company.

BRIDGES, ROADS AND PAVEMENTS.

Brockville, Ont.—There is a probability of Main Street being paved at a cost of $53,000. Mr. J. H. Bryson is the engineer of this municipality.

Toronto, Ont.—As a means of lessening the traffic on Queen Street the municipal Works Committee have recommended that Sydenham Street be extended westerly to Shuter Street. The estimated cost of this work is given as $65,000.

Toronto, Ont. — The Works Commissioner will confer with the proper railway officials on the matter of constructing a bridge over the tracks near the ferry wharves on Bay Street.

Victoria, B.C.—The City Engineer will experiment on the dust laying properties of oil on the streets of this city.

FIRES.

Crescent Valley, B.C.—The planing mill of the British Canadian Lumber Company was destroyed by fire. Crescent Valley is near Nelson.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending June 3rd, 1912:—

A Welsh firm of mineral water manufacturers desire to appoint as their agents a first-class Canadian house having branches all over the Dominion.

A London firm desire the representation of a Canadian wood pulp manufacturer.

A London correspondent is prepared to negotiate with Canadian manufacturers for the sole right to manufacture in the Dominion certain specialties in which he is interested, and which include paints, enamels, soaps, varnishes, soluble oil, distempers, disinfectants, etc.

A North of England firm of glass manufacturers are considering the appointment of Canadian agents.

A London firm make inquiry for the names of Canadian manufacturers of maple meat skewers.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:—

A Nottingham company manufacturing laces of all classes are open to consider the appointment of responsible resident agents in the principal Canadian centres.

A Yorkshire company manufacturing wire for brushes, meters, mattresses, cloth, and all purposes except fencing; also wire ropes, twines, and engineers' supplies, wish to make arrangements for the sale of their goods in Canada.

PATENTS.

The following is a list of patents recently issued through the agency of Messrs. Ridout & Maybee, Manning Chambers, Toronto, Canada:—B. R. Seabrook, tops for cans and the like (case 1); B. R. Seabrook, tops for cans and the like (case 2); J. T. Thompson, display devices; W. R. D. Innes, railway sleepers (tie); John Little, rail placing machine; Fred. McRea Bawden, molds for pneumatic tire covers.

United States:—Clifford Guise, swivel; George Fulton, wooden floor coverings; H. E. T. Haultain, weight recording mechanism; H. E. T. Haultain, registering weighing apparatus.

OBITUARY.

E. H. Keating, former municipal engineer of Toronto and later general manager of the Toronto Railway Company, died at his home, 9 Castle Frank Crescent, Toronto, on June 18th last.

Mr. Keating was a native of Halifax, Nova Scotia, and received his early education at the Dalhousie University and the Chicago Academy, after which he studied engineering under Mr. George Whiteman, Provincial Government Engineer of Nova Scotia, and Sir Sandford Fleming.

In his earlier engineering career Mr. Keating was assistant engineer of the Pictou Extension Railway in Nova Scotia, chief draftsman of the Windsor and Annapolis Railway, contractors' engineer for the European and North America Railway, N.B., assistant engineer of different divisions of the Intercolonial Railway, division engineer in charge of exploration for the Canadian Pacific, City Engineer of Halifax, N.S., and also engineer of the Halifax graving dock.

It was while City Engineer of Duluth that the then Mayor, R. J. Fleming, invited Mr. Keating to Toronto to become City Engineer, which position he held from 1892 to 1898.

Mr. Keating was recently honored by the Institution of Civil Engineers of Great Britain. He is a Past President of the Canadian Society of Civil Engineers, a members of the Engineers' Club, Toronto, and the American Society of Civil Engineers.

"ROCMAC" MACADAM BINDER.

Power was turned on at the new mill of the Rocmac Road Corporation at Thorold, Ont., last week and this firm is now prepared to fill orders for Rocmac solutions made in Canada.

Although distinctly a Canadian Company, the Rocmac Road Corporation has had a mill in operation at Tonowanda, N.Y., for over a year, and has met with considerable success in New York State. Originally Rocmac was an English road and was first laid in Halifax, England, on the Skircoat Green Road, in 1907. The results on this first road have been excellent, especially in contrast to an adjoining length of ordinary macadam. Rocmac has also worn well on roads in the United States and Canada and has shown up particularly well on a strip of road in Victoria Park, near the Horseshoe Falls, where it is almost continuously wetted by the spray from the falls.

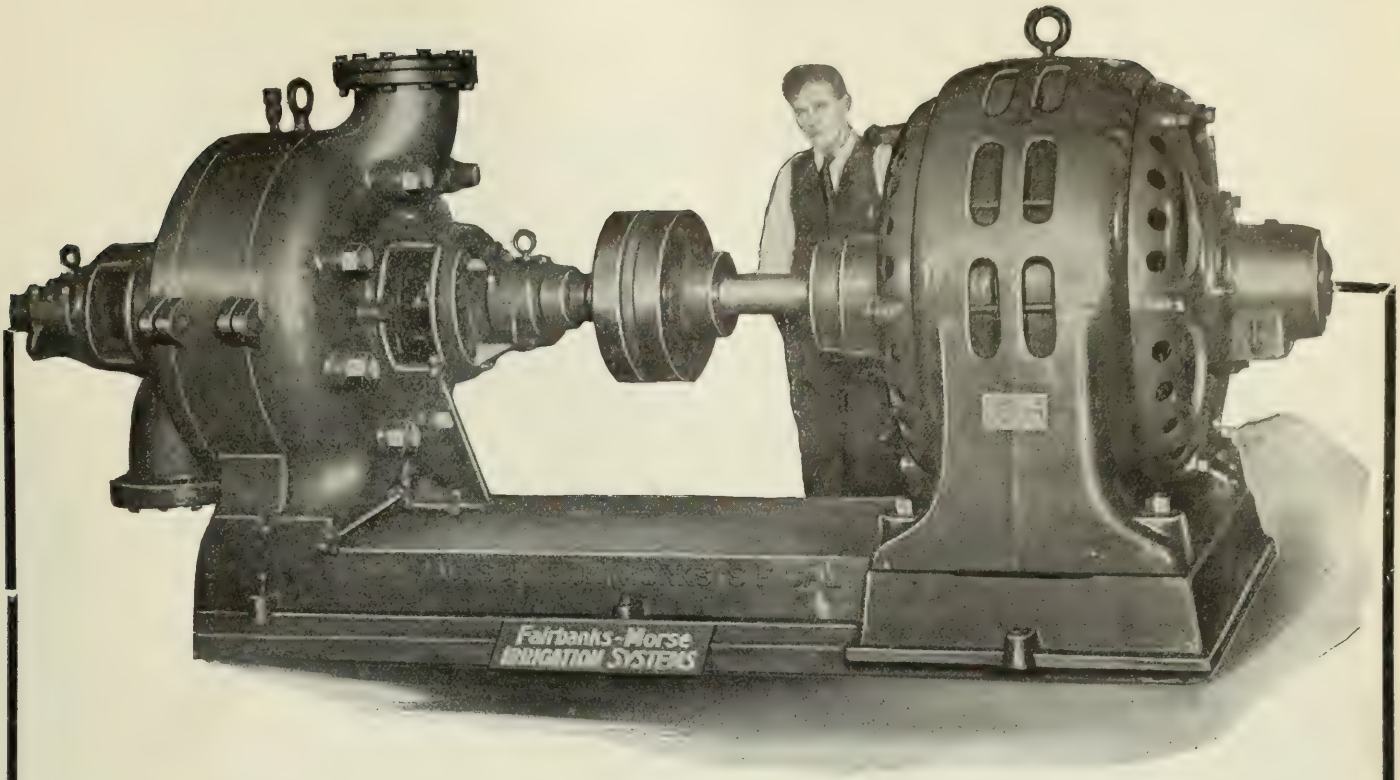
The chief difference between Rocmac and the ordinary macadam is in the binding material. The requirements of a good road are far more exacting to-day than in Macadam's time, and automobiles require a dustless, durable road, formed with a binder which will not disintegrate or deteriorate and which eliminates, or greatly reduces, maintenance charges. It is said that the Rocmac solution fulfils these requirements of a good binder.

The materials used in the construction of Rocmac are limestone, containing a specified proportion of carbonate of lime, crushed to pass a ¼" screen; any hard rock ordinarily used for macadam roads, preferably trap or granite of a size known as No. 2 or No. 3, mixed in about equal proportions of each; and the Rocmac chemical solutions.

The method of building the road is to form a matrix by thoroughly mixing the limestone dust with the solution; this matrix is laid upon the road and the macadam is placed upon the top of it and rolled in until the matrix entirely fills up the interstices and comes to the surface.

When the road has become thoroughly packed by the rollers, a grout appears from the matrix below, so proving that all cavities have been filled. A thin coating of limestone is spread over the road to absorb the excess of solution and to form a cushion for the horses' feet while the process of setting goes on. Traffic is not impeded during construction.

The Rocmac solution is a silico-saccharate. It contains no asphalt, pitch, tar or oil and is entirely harmless to surrounding property during the laying or after the completion of the road. There is no unpleasant odor or damage to vegetation, vehicles or clothing. The surface of the road when finished has the appearance of an ordinary macadam road. A point in favor of Rocmac which will be thoroughly appreciated by Canadian engineers in some sections of the country is that it can be laid in any weather.



The Largest Direct Connected Centrifugal Pumping Unit in British Columbia.

The Vancouver Power Company have recently installed at their works at Coquitlam Dam, B.C., the largest direct connected centrifugal pumping unit in British Columbia. This outfit is to operate in parallel with a number of other pumps that are to furnish water under pressure for sluicing into place the material for their new dam.

This pump is a 10-inch, class "F," two-stage centrifugal, with bronze inpellers and renewable bronze diffusion vanes. It has a normal capacity of 1833 imperial gallons per minute when operating at 1160 r.p.m. against a total head of 355 feet or an equivalent pressure of 154 lbs. per square inch. It is mounted on a common sub-base with a 300 h.p. type "B," Fairbanks-Morse squirrel cage, induction motor, 2200 volts, 60-cycle, 3-phase, 1160 r.p.m. at full load, being direct connected thereto by means of a flexible leather link coupling

The motor possesses a feature in rotor construction that is unique. The end rings are welded on to the rotor bars by a new process, making a perfect joint, free from the troubles common to the purely mechanical or riveted joint, such as oxidation, working loose, and solder-throwing. This improvement marks a long step forward in the elimination of rotor trouble.

Our Vancouver Branch supplied and assembled this complete pumping unit. We are in a position to quote on the necessary equipment for any pumping requirements on receipt of specifications.

The Canadian Fairbanks-Morse Co., Limited

Fairbanks Standard Scales, Fairbanks-Morse Gas Engines
Pumps Safes Vaults

MONTREAL, ST. JOHN, OTTAWA, TORONTO, WINNIPEG,
CALGARY, SASKATOON, VANCOUVER, VICTORIA.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16270—April 10—Dismissing application of town of Battleford, Sask., re C.N.R. branch line passenger service.

16271—April 10—Dismissing complaint of Namaka Farmers' Association No. 122, of Namaka, Alta., re mail service by C.P.R.

16272—March 16—Directing C.N.O. Ry to construct foot subway of concrete through property of Deaf and Dumb Institute at station [illegible], near Belleville, Ontario.

16273—April 9—Approving revised location of C.P.R. Lacombe Easterly Branch, mileage 100.07 to 146.10, Alberta.

16274—April 10—Authorizing C.P.R. to reconstruct bridge No. 30.5 on its Temiskaming Subdivision.

16275—April 11—Amending Order 15995 of Feb. 16, 1912; by substituting "1-2 George V., Chapter 22, Section 10" for "8-9, Edward VII., Chapter 32, Section 10" in recital and operative parts of Order.

16276—April 11—Postponing effective dates of M.C.R. Tariff, C.R.C., No. 1874; G.T.R., C.R.C., No. E. 2376, as amended by Supp. No. 1; Wabash R.R., C.R.C., No. 566, as amended by Supp No 1; advancing rates on anthracite coal, Niagara Frontier to Canadian points.

16277—April 11—Authorizing South Ontario Pacific Rly. Co. (C.P.R.) to construct its Guelph Jct. to Hamilton Branch underneath power wires of Hydro-Electric Power Commission at mileage 13.32, from Guelph Jct.

16278—April 9—Approving locations of 8 G.T.P. Ry. stations in Coast and Cassiar Districts, British Columbia.

16279—April 11—Authorizing G.T.P. B.L. Co. to operate trains over crossing of its Melville-Regina Branch with C.P.R. Main Line in Sask. account interlocker completed.

16280—April 11—16281—April 12—Approving location of C.N. Alberta Ry., mileage 166.01 to 192.83, and to occupy portion of right-of-way of G.T.P. Ry. about mileage 185.5; and approving location from mileage 192.83 to 222.79, Alberta.

16282—April 12—Authorizing C.N.R. to construct bridge across Pembina River in S.W. ¼ Sec. 29, Twp. 53, R. 7, west 5 M.

16283—April 12—Approving revised location of C.N.O. Ry. in Twp. of Ferris, Dist. of Nipissing, mileage 339.5 to 340.72.

16284—April 12—Authorizing C.N.R. to construct bridge across McLeod River, in west half of Sec. 33, Twp. 52, R. 17, W. 5 M.

16285—April 10—Authorizing Esquimalt & Nanaimo Ry. (C.P.R.) to take lands for railways purposes Lots 54 and 55 of Lime Bay, Sec. 31, Victoria West, in British Columbia.

16286-87—April 11—16288-89—April 10—Authorizing C.P.R. to construct spurs for the Alsip Brick, Tile and Lumber Co., Ltd., at Parish, Lot No. 71, St. Boniface, Man.; for Wolverton Milling Co., Ltd., at Wolverton, Ont.; for H. Hilton & Sons, city of Winnipeg, Man., and for Ballast Pit, near Marquette, Man., and to cross 4 highways to same.

16290—April 11—Authorizing C.N.R. to cross public road between S.E. ¼ Sec. 3, T. 39, and N.W. ¼ of Sec. 33, T. 38, R. 27, W. 4 M.

16291-92—April 11—Authorizing C.N.O. Ry. to cross public roads (2) in Twp. of Fitzroy, County Carleton, Ontario.

16293-94-95-96—April 12—Authorizing C.P.R. to reconstruct 5 bridges on its McLeod, Sherbrooke, Ottawa, Mountain and Farnham Subdivisions, bridge No. 54.4, Muskoka Subdivision, Bridge No. 92.3 Boundary S.D., and Bridge 54.0 over new cut McLeod S.D.

16297—April 12—Authorizing Twp. of Roxborough to construct highway across C.P.R. near Mountain, Twp. Roxborough, Ont.

16298—April 12—Authorizing C.P.R. to construct spur into premises of Canadian Carbon Co., Ltd., Winnipeg, Man.

16299—April 12—Authorizing C.N.O. Ry. to cross public road between Cons. 1 and 2, Ottawa Front, Twp. Nepean, Ct. Carleton, Ont.

16300—April 12—Approving details of structure to be built by G.T.P. B.L. Co. authorized by Order 15088, Oct. 13, 1911.

16301—April 12—Authorizing C.P.R. to construct bridge 65.3 over Irrigation Siphon, Calgary Subdivision.

16302—April 13—Approving by-law of Midland Rly. of Canada (G.N.R.) authorizing Charles E. Dafoe, Supt. and Gen. Frt. and Pass. Agt. to prepare and issue tariffs of tolls.

16303—April 13—Authorizing C.N.O. Ry. to cross public road between Lots 10 and 11, Con. 4, Twp. of March, Ct. Carleton, Ont.

16648—April 23—Approving location of C.P.R. freight shed at Saskatoon, Sask.

16649—May 29—Authorizing Kettle Valley Ry. Co. to cross highway at mileage 10.5, northwest of Penticton, B.C.

16650—May 29—Authorizing Kettle Valley Ry. Co. to cross 6 highways in the municipality of Summerland, B.C.

16651—June 1—Authorizing C.P.R. to construct three spurs into premises of Union Stock Yards Co., Toronto, Ont.

16652—May 30—Relieving V.V. & E. Ry. (C.N.R.) from erecting and maintaining fences along certain portion of its line.

16653—May 31—Authorizing city of Hamilton to construct subway under G.T.R. near Sherman Inlet, (Birch Ave.)

16654—May 29—Authorizing G.T.P. Ry. to construct branch line into Secs. 18 and 7, Twp. 53, R. 23, W. 4 M.

16655—May 31—Authorizing C.N.O. Ry. to construct spur from point on joint section of C.P.R. spur in Parry Sound, Ont., into premises of Canada Chemical Co.'s smelter.

16656—May 31—Extending until Oct. 1st, 1012, time for installation of interlocker by C.N.O. Ry. to cross C.P.R. and G.T.R. near Ottawa, Ont. See Order 11386, Aug. 6th, 1910.

16657—May 30—16658—May 31—Authorizing Campbellford, Lake Ont. and Western Ry. to cross C.N.O. Ry. in Lot 27, Con. 2, Twp. of Pickering, Ont., and Pointe-Anne Railway Co. (Canada Cement Co.) in Lot 15, Con. 1, Twp. of Thurlow, Ontario. Interlocking plants to be installed.

16659—May 30—Approving location of Campbellford, Lake Ont. and Western Ry. (C.P.R.) from mileage 72 to 75.45, Ontario.

16660—May 27—Directing C.P.R. to file within 90 days plan showing location of junctions with C.N.R. and interlocking signalling system to govern movements over tracks of 2 Cos.

16661—May 31—Dismissing application of C.P.R. to construct its Lambton to Weston Line across certain highways in Twps. of York and Etobicoke, Ontario.

16662—May 31—Dismissing application of C.P.R. to construct Lambton to Weston Branch to connect with Toronto to Owen Sound line near Toronto, Ont.

16663—May 31—Refusing application of C.P.R. for branch line from its Toronto to London line to connect with Toronto to Owen Sound line near Toronto, Ont.

16664—May 30—Authorizing C.P.R. to take lands in civic St. Andrew's Ward, Montreal, Que., for railway purposes.

16665—May 31—Orders that crossing of C.P.R. of Dovercourt Road, Toronto, be protected by day and night watchman, one-half wages by city of Toronto and one-half by C.P.R.

16666—June 4—Authorizing G.T.P. Ry. to open for carriage of traffic its line from mileage 100 to 164 east of Prince Rupert, B.C., limited to speed of 25 miles an hour.

16667—May 31—Directing C.P.R. to install standard gates at crossing in village of Hartland, N.B., within 60 days, to be operated between 7 a.m. and 6 p.m. daily, 20 per cent. from Railway Grade Crossing Fund.

16668—June 1—Authorizing Vancouver, Westminster & Yukon Ry. Co. and C.P.R. to operate their trains over crossing at Burrard Inlet, Vancouver, B.C., without stopping.

16669-70—May 30—Approving location of Campbellford, Lake Ont. & Western Ry. (C.P.R.) from mileage 106.7 from Celn Jay to mileage 123, and authorizing it to cross by means of an overhead bridge the Thurlow Railway Co.'s tracks to Canada Cement Co.

16671—June 1—Directing G.T.R. to compensate existing landowners on either side of Ferguson Avenue, Hamilton, Ont., who were owners prior to establishment of Cannon Street Yard, or to have option of purchasing same outright, etc. Application, city of Hamilton re shunting on Ferguson Ave.

16672—June 5—Authorizing C.P.R. to open for carriage of traffic second main line double track from St. Martin's Jct. to St. Therese, distance of 7.22 miles.

16673—June 4—Authorizing G.T.P. Ry. to construct two spurs to serve Alsip Brick & Supply Co., at Edmonton, Alta.

16674—June 7—Authorizing G.T.P. Ry. to cross and divert highway at mileage 58.3, Alberta.

16675—June 7—16676—June 4—Authorizing G.T.P. B.L. Co. to cross two highways on its Biggar-Calgary Branch, and to divert road from mileage 36.4 to 36.8 on its Regina-Moose Jaw Branch.

16677—June 5—Authorizing G.T.P. Ry. to cross highway at mileage 193.5, Range 6, Cassiar Dist,, B.C.

16678—June 4—Approving location and detail plans of G.T.P. B.L. Co station at Bardo, on its Tofield-Calgary Branch.

16679—June 5—Authorizing G.T.R. to construct siding into premises of Canada Brick Co., Ltd., near Montreal, Que.

16680—June 6—Authorizing G.T.R. to reconstruct bridge 4.90 on 16th Dist., near Waterdown, Ontario.

16681—May 30—Authorizing G.T.R. to construct 2 additional tracks across Bay Street, Kingston, Ont.

16682-83—June 4—Authorizing G.T.R. to construct siding for Bronson Company, in Ottawa, Ont., and for Dominion Flour Mills Co., Ltd., Montreal, Que.

16684—June 8—Extending until 15th July, 1912, time for completion of transfer track at Minto, Man. See Order 16501, May 10, 1912.

16685—June 4—Granting extension to C.P.R. for construction of spur until 30th Nov., 1912. See Order 16289, Apr. 10, 1912.

16686—June 7—16687—June 6—Authorizing C.P.R. to construct spur for Frank H. Wiley, in Winnipeg, Man., and for Hub Roofing and Cornice Works, Co., Saskatoon, Sask.

16688—June 8—Approving location of C.P.R. station at Yahk, B.C.

16689—June 5—Authorizing C.P.R. to construct spur for National Portland Cement Co., Ltd., Twp. of Brant, Bruce County, Ont., (near Hanover, Ont.).

16690—June 8—Authorizing C.P.R. to reconstruct bridge 86.1 and 57.9 on its Havelock and London Subdivisions.

16691—May 4—Authorizing C.P.R. to construct branch line to premises of Winnipeg Supply Co., Ltd., Winnipeg, Man.

16692—June 6—Authorizing C.P.R. to reconstruct bridge No. 113.5 on its Cascade S.D., B.C. Division.

16693—June 4—Authorizing C.N.O. Ry. to cross two highways in Twp. of Ross, County of Renfrew, Ontario.

16694—June 4—16695—June 7—Authorizing Campbellford, Lake Ont. and Western Ry. (C.P.R.) to take possession of portion of C.N.O. Ry. right-of-way at mileage 79.5, in Twp. of Sydney, Ont., and approving revised location from mileage 140.63 from (Glen Tay) to mileage 147.89 in County of Durham, Ontario.

16696—June 7—Approving revised location of C.N.O. Ry. through unsurveyed territory, Dist. of Thunder Bay, mileage 142.8 to 148.4, from Port Arthur.

16697—June 4—16698—June 6—Authorizing C.N.R. to cross with its Swift Current Line 23 highways in Saskatchewan, and with its MacLeod-Calgary Branch, 24 highways in Alberta.

16699—May 31—Authorizing city of Hamilton to construct Dunsmure Road across spur of T.H. & B. Ry.

16700—June 1—16701—June 4—Authorizing city of Edmonton, Alta., to cross with its electric railway the tracks of G.T.P. Rv. at Spruce Ave., and at intersection of 21st Street, with Short and Nelson Avenues; half interlockers to be installed, etc.

16702—June 7—Directing G.N. Ry. to fence its right-of-way from Elko to International Boundary with exception of where it skirts the Kootenay River, etc. Complaint, Board of Trade, Elko, B.C.

16703—June 7—Authorizing Government of Alberta to construct highway across C.P.R. on north boundary of N.E. ¼ S. 3, T. 39, R. 27, W. 4 M.

16704—May 31—Authorizing Montreal Tramways Co. to reconstruct bridge over C.P.R. near Blue Bonnets, Que.

16705—June 5—Directing that Order 16479, May 10, 1912, be put into effect by Railway Companies not later than 15 July, 1012.

16706—June 5—Authorizing Peterborough Radial Railway Co. to cross C.P.R. and G.T.R. on Park Street, Peterborough, Ont.

16707—June 4—Amending Order 16452 of Mar. 6, 1912, to substituting words, "forty thousand pounds" for words "thirty thousand pounds," where they occur in said Order.

16708—May 31—Directing T.H. & B. Rv. to protect Walnut Street crossing by day and night watchman; gate question reserved.

16709—June 5—Recommending to the Governor-in-Council agreement between Atlantic, Quebec & Western Ry., and Quebec Oriental Railway for joint shops at New Carlisle, Que.

Volume 22 Toronto, June 27, 1912

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The Canadian Engineer

An Engineering Weekly

LARGEST REINFORCED CONCRETE ARCH BRIDGE IN THE WORLD.

There was built last year in Rome a bridge over the Tiber, which possesses special interest because of the fact that the span exceeds everything hitherto attempted in reinforced concrete construction. This bridge is called Ponte del Risorgimento.

The arch proper has a span of 333 ft. (100 m.), with a 33 ft. rise, (Fig. 1).* At the crown the thickness is reduced

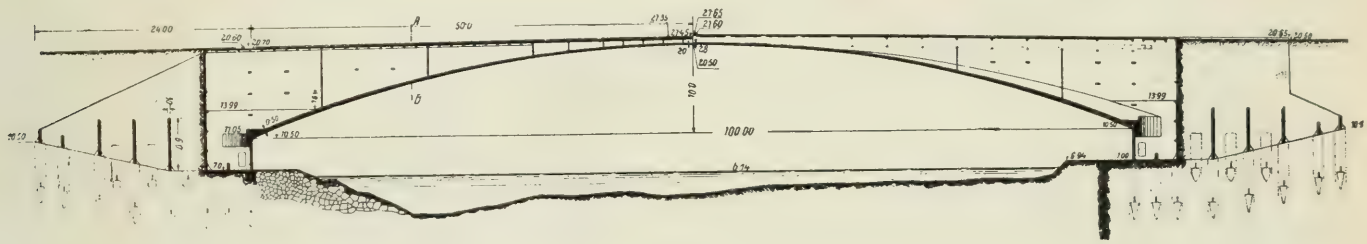

Fig. 1.

to the remarkable dimension of 8-in. (20 cm.), from this point it has been increased until it is 20-in. (50 cm.) at the springing lines. The bridge is materially strengthened by 8-in. thick stiffening ribs, which extend its whole length, and over the abutments. These consist of the above-mentioned ribs connected by cross walls and supported by concrete columns, (Fig. 2 and 3), constructed in the following manner.

A heavy conical hammer, (Fig. 4), is raised to a certain height and is allowed to fall, so that it pierces to firm ground;

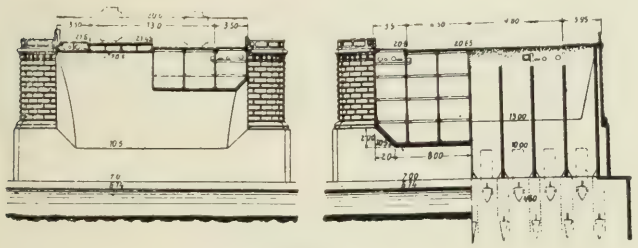

Fig. 2.

this is, of course, obtained by repeated operations, similar to pile driving. The form of this hammer ensures the surrounding earth being firm and strong, so that even when driving through loose earth, the walls of the hole will remain standing.

In cases where water percolated into the hole it was necessary to adopt some precaution to keep it dry, so as to obtain satisfactory concrete work. The manner of procedure was to introduce a quantity of clay which was compressed against the walls by the action of the rammer; in this way water was successfully kept from interfering with the concrete.

When holes had been driven down to firm ground a large quantity of gravel was introduced and rammed hard with an oval monkey for obtaining a firm footing for the concrete afterwards placed in the hole. In order to connect these

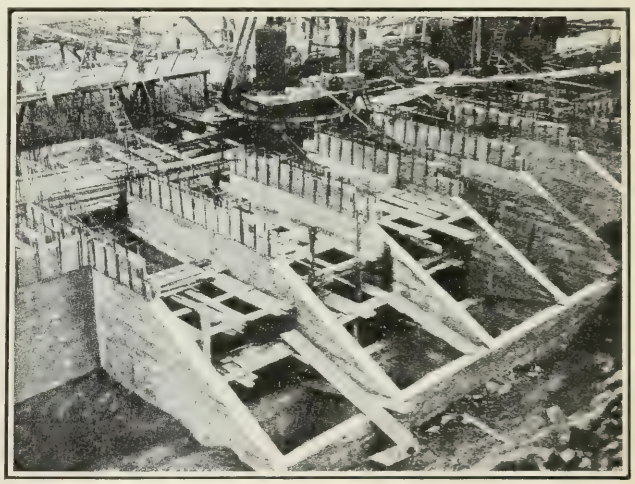

Fig. 3.—View Showing Lower Part of Abutments.

concrete piles and the superstructure a number of vertical bars were embedded in the piles.

The foundation work was done between the months of January and July, and there were frequent interruptions due to highwater in the river.

* The total width of the dredge between the triangle is 64 ft., of which the roadway is 44 ft. and the sidewalk on each side 10 ft.

At one end of the bridge a wall of rock formed a strong natural protection and prevents any damage being done by the water to the abutments; at the other end of the bridge this protection is obtained by reinforced concrete sheet piling, connected together by tongue and groove joints. These piles were sunk in position by the use of a water jet, the water being brought to the end of the piles under a head of 70 ft.

In the reinforcement of the bridge only two sizes of bars were used,* the unusual section of these bars is shown in Fig. 5, and is the design of Mr. Porchedder, (Turin), the head of the contracting firm who undertook the work.

The whole design is based on a live load of 100 lbs. per sq. ft., or 3 steam rollers weighing 33,000 lbs. each, placed in the most dangerous position.

A remarkable feature in connection with this bridge was the use of reinforced concrete scaffolding, (Fig. 6 and 7). This was of such a nature, that very little resistance was offered to the flow of the water, and at the same time great strength was obtained. The resistance power was brought out by the fact that a steamer in trying to pass under the bridge at high tide inadvertently struck two of the piles and broke them off, (Fig. 8). Notwithstanding this accident the scaffolding was still able to support the recently placed concrete.

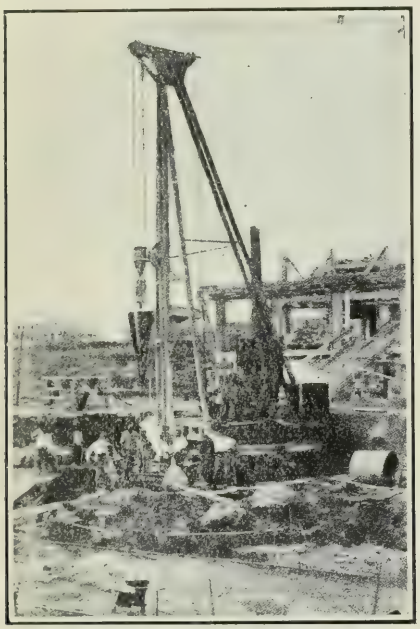

Fig. 4.

The scaffolding was built up so that each row of columns rested on 16 concrete piles placed in two rows and connected above the water-line by a beam, (Fig. 9); each group of piles constitutes a support for reinforced concrete columns, which are again framed together by a second cross beam, on which were laid wedges and wood beams for the forms.

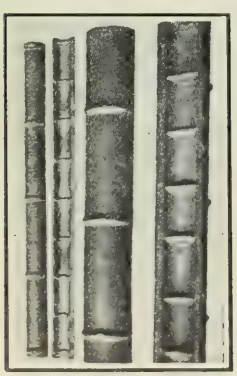

Fig. 5.

The columns and beams for this scaffolding were constructed separately, floated to the bridge and joined together by the reinforcement, filled out with cement mortar. The erection thus occupied a very short space of time.

*With sectional areas of .175 and .61 sq. in. respectively.

A concrete mixture of 500 lbs. of cement per cubic yard was used, and the consistency was very wet.

Fig. 6.

The contract price for the bridge was about $200,000.

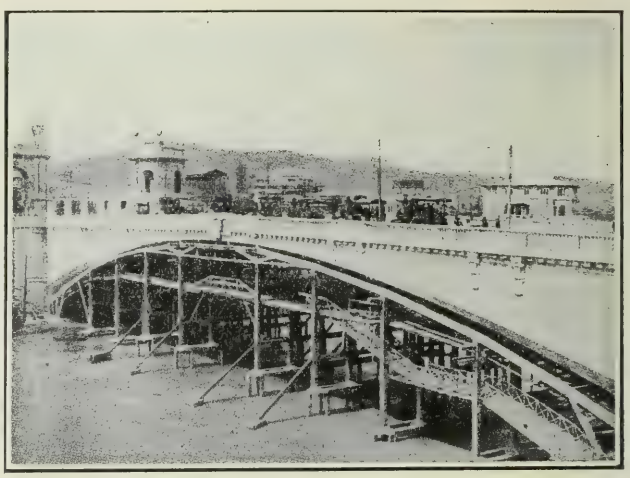

Fig. 7.—Testing Bridge by Seven Steam Rollers.

For purposes of comparison a list of the principal dimensions of some other large arch bridges is given in the table on the following page.

Fig. 8.

On page 847 of this issue of *The Canadian Engineer* will be found an article by Mr. Henry G. Tyrrell entitled "American Impressions of the Risorgimento Bridge at

Rome." This article, read in conjunction with the foregoing description will be of interest to our readers.

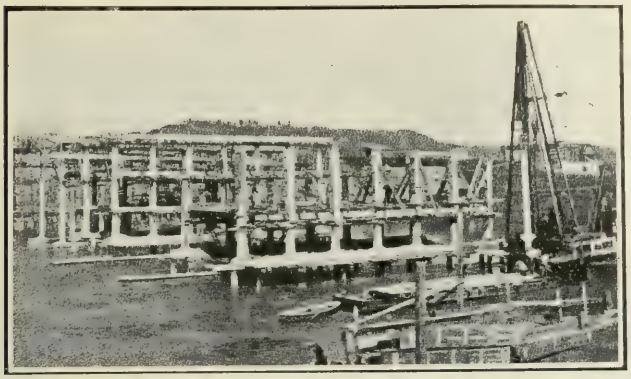

Fig. 9.

Table of Long Concrete Arches.

NAME	Used for	Built in	Span ft.	Rise ft.	Crown-thickness in.	Thickness at springing lines, in.	Material
Bridge over the Petursse-Tal, Luxembourg	Street ..	1900/03	240	55	57	86	Sandstone
Bridge over the Adda Line Colico-Sondrio, Italy	Railway	1902/04	233	34	60	88	Granite
Bridge over the Steyrling Line Wienera - Triest. Austria	Railway	1903/04	233	52	80	136	Granite
Bridge over the Isar, Munich	Street ..	1903/04	233	42	32	36	Reinforced Concrete
Bridge over the Tsonzo Line Triest-Klagenfurt, Austria	Railway	1904/05	284	73	84	140	Limestone
Walnut Lane Bridge in Fairmount Park, Philadelphia	Street	1906/08	237	72	67	116	Concrete
Bridge at Teufen, Schwizelaw	Street ..	1908	263	88	48	85	Reinforced Concrete
Bridge over the Valserine, France	Railway	1908/09	268	66	60	100	Limestone
Grafton Bridge in Auckland, Australia	Street ..	1907/10	320	86	67	73	Reinforced Concrete
Bridge in Cleveland (Ohio)	Street ..	1908/10	284	81	73	134	Concrete
Bridge in Milwaukee (Wis.)	Street ..	1909	256	58	48	96	Reinforced Concrete
Bridge in Spokane (Wash.)	Street ..	1909/11	285	117	82	226	Concrete
Bridge in Constantine (France)	Street ..	1910/11	233	83	60	60	Concrete

STADACONA HYDRAULIC COMPANY:

Announcement has been made at Quebec of the organization of the Stadacona Hydraulic Company, which is undertaking the development of the power at Seven Falls, back of Ste. Anne de Beaupre. The falls, which have a head of over 400 feet, will at present enable the company to obtain an initial development of 10,000 horse-power. The company is backed by a group of Montreal, Quebec and foreign capitalists, and the arrangements concluded, it is said, will result in the company being able to deliver power by the end of the present year. Among the interests identified with the company are: President, Hon. L. P. Pelletier, postmaster-general of Canada; Sir Rodolphe Forget, M.P.; Neuville Belleau, banker, Quebec; Hon. C. E. Dubord, Quebec, member of the Legislative Council of the Province of Quebec; Mr. D. O. Lesperance, banker, Quebec; Mr. Alfred Bouvier, Brussels; Mr. H. J. Bierman, Shawinigan Falls; and Mr. Andre de la Morinerie, France.

DESTRUCTION OF CEMENT MORTARS AND CONCRETE THROUGH EXPANSION AND CONTRACTION.

One of the most important of the standard tests for Portland cement is that for "Constancy of Volume"—a lulling title which carries with it the implication that our cements are actually constant in volume. It requires no very keen observer to find numerous instances where the implication has not been justified. Cracked copings and walls, sidewalks warped and split, and stucco dropping from houses, are sights which are so frequent as to force upon the observer the feeling that the phenomena must be due to some property characteristic of many if not all concretes which are exposed to the weather.

Professor A. H. White, of the University of Wisconsin, gave the results of his investigation of the subject in a paper before the American Society for Testing Materials. The paper in abstract form, as here given, is most interesting.

The change in volume of concrete due to temperature change has been determined with considerable accuracy to be for unit length 0.0000055, or 0.00055 per cent., per degree Fahrenheit. There are, however, other changes due to the chemical processes of setting and hardening which are barely mentioned in even the more important treatises, and other variations due to the wetting and drying of the concrete whose very existence is practically unknown. It is with these two latter classes of changes that this paper will deal.

The following pages show especially the effect of alternately wetting and drying bars of neat cement and sand mortar. There are also included the behavior of various bars of neat cement kept continuously in water and in air. These are included not only because more data on the subject are desirable, but because the Portland cement now being used is a different material from that tested by the European investigators, who undoubtedly worked with cements made in the old vertical kilns. The modern American cement made in rotary kilns differ from the older not only in method of manufacture but also in chemical composition, and is worthy of separate study.

Experimental Method.—The method of making and measuring the expansion bars was that of Campbell and White. The dimensions of the bars are approximately 1 by 1 by 4 ins., and they contain bevelled glass plates cast into the end to ensure a smooth surface for the micrometric measurements. The Portland cements used were all commercial samples which passed successfully the standard tests for soundness. Standard methods were used in proportioning the water and in mixing. The initial measurement was made after the bar had stood 24 hours in the damp box.

Illustrations from Actual Practice.—It may be urged that the tests were all made on small bars manufactured in the laboratory and that such large values might not be obtained in actual practice.

Bar 156 A is made from a part of the cement sidewalk on the north side of the campus of the University of Michigan. It was laid in 1890 from imported German cement by the University workmen who were paid by the day and under no temptation to slight the work or skimp cement. Most of the slabs of this walk are now warped slightly so that shallow puddles of water stand in them after rain, and even after twenty years the expansion is still occasionally causing adjacent blocks to heave and form an inverted "V." The top layer is split from the bottom in many places and it was from one of these pieces of the top coat that bar 156 A was sawed. An examination of its lower surface shows that the split was not due to faulty bonding, for the break has occurred not at the exact junction of the top coat and base,

but just below the upper surface of the base. The top coat carries with it a thin layer of the base. This bar became dampened in the sawing process and was therefore put into water and allowed to become saturated and fully expanded before the measurement recorded as the initial was made. It then contracted slowly for 14 days in the air, the total shrinkage being 0.05 per cent., and on putting it into water it expanded to practically its initial volume in 4 days. When removed from water it contracted again as before.

Another instance to which attention is called is bar 156 E, cut from a piece of cement stucco which came loose from a brick porch after only two years' service. The stucco is well mixed, has a good ring and is hard. The brand of cement used and the proportions are unknown, but it is certainly a rich mixture, probably as high as 1:1. The stucco in coming off did not split off from the brick but in almost all instances carried a thin skin of the brick adhering to it, showing that the fault did not lie in failure to bond the materials together. The behavior of a bar sawed from this stucco is shown in the curves for 156 E. It was sawed to shape without moistening, and when placed in water for 24 hours it expanded 0.07 per cent. and reached 0.08 per cent. after 4 days in water. On drying in air is slowly returned to its original volume. It is not to be wondered at that a stucco which expands practically 1 in. in 100 ft. whenever it gets thoroughly wet, should fail.

Another instance of change of volume in material which has been in use many years is afforded by the study of a section of cement sidewalk which was taken up in good condition after 20 years' service. From this was sawed a bar approximately 1 by 2 by 4 ins., consisting of the top coat 1 by ¾ by 4 ins. on a section of the bottom portion 1 by 1¼ by 4 ins. This bar (156 B) is, therefore, similar in many ways to the compound bars of neat cement and 1:3 mixture before referred to. It showed the usual expansion of both layers in water and the contraction in air which was expected. When placed in water the bottom layer expanded practically its whole amount (0.033 per cent.) in 15 minutes, while the richer top layer expanded in the same time only 0.010 per cent. At the end of 24 hours the top portion had expanded 0.028 per cent., and after 3 days had become practically constant with almost the identical expansion 0.035 per cent., which the bottom showed. This is interesting partly because of the evidence of alternate bending stress in the concrete due to the more rapid expansion of the lower layer and partly because of the ultimate agreement in expansion of the top and bottom portion. Note that this cement sidewalk was in good condition after 20 years' service. It is possible that its satisfactory condition is due to this agreement in coefficient of expansion of the two layers.

Summary of Experimental Data.—In the foregoing there have been presented data on the sadly neglected subject of expansion and contraction of hydraulic cements as they age in water and in air and as they are alternately wet and dry. It should be emphasized, however, that the number of experiments is entirely inadequate to make it proper to quote them as average results. They are to be regarded merely as illustrations of how some acceptable commercial cements have behaved. It is, however, permissible to summarize the extremes to show the range of fluctuation.

Neat cement bars hardening under water.—After 1 year, expansion 0.07 to 0.15 per cent.; 1 year to 4 years almost no change; on drying after 3 years in water, contraction 0.13 to 0.15 per cent.; on wetting again, expansion 0.13 to 0.17 per cent.

Neat cement bars hardening in air.—Contraction after 3 months, 0.14 to 0.28 per cent., after 1 year, 0.18 to 0.34 per cent., with slight increase to 4 years.

Cement-sand bars, 1:3.—Hardening under water, expansion 0.01 to 0.05 per cent., the greatest changes being in the first few weeks; hardening in air, contraction 0.06 to 0.09 per cent., most of the contraction being in the first three months; on wetting and drying, expansion 0.04 to 0.09 per cent. on wetting, and contraction within same limits on drying.

Compound bars made of one layer of neat cement on a layer of 1:3 sand expand and contract together but at different rates and to different degrees. The differential expansion varies from 0.00 to 0.15 per cent.

The one natural rock cement tested showed twice as much variation in volume as Portland cement.

These variations in volume with change of moisture content do not disappear with lapse of years, for changes of 0.05 and 0.06 per cent. have been observed in bars cut from sidewalks which have been laid 20 years.

Changes in Monolithic Cement and Concrete.—These changes noted above may seem small, but when converted into other figures their real seriousness becomes apparent. The following hypothetical illustrations are presented to show the magnitude of the possible stresses.

Imagine a wall of neat Portland cement 100 ft. long anchored at each end to absolutely immovable supports. Let it be kept under water for 3 years. At the end of that time it would, had it been free, have expanded 0.1 per cent., or 1.2 ins. Since it is supposedly not free to expand the compression will be 0.1 per cent. and the compressive stress, on an assumed modulus of elasticity of 5,000,000, will be 5,000 lbs. per sq. in. Perhaps the cement could withstand this pressure.

Imagine now that this cement wall becomes dry. It should contract 1.7 ins., but since it is not free there will be developed a tensile stress of 7,500 lbs. per sq. in., which is several times more than it can stand. The wall would have to crack.

Suppose this neat cement wall had been originally allowed to harden in the open air. After 2 years it would, if free, have contracted 0.25 per cent., but since it is anchored at the ends there will be (assuming the same modulus) a tensile stress of 12,000 lbs. per sq. in. Is it not evident why neat cement is not used in practice?

If the above wall had been built of concrete with the same volume changes as the 1:3 sand bars and as the old sidewalks whose measurements are given above, its change in length between the wet and dry states would probably have amounted to 0.05 per cent., which with a modulus of elasticity of 2,500,000 lbs. per sq. in. corresponds to a stress of 1,250 lbs. per sq. in. The concrete could withstand this in compression but not in tension. Not even our best steel will stand indefinitely repeated alternate bending stresses nearly to its elastic limit. Why should we wonder, then, if a rich cement mixture should ultimately crack when exposed to the stress resulting from a volume change of 0.05 per cent. every time it is exposed to rain or sunshine.

There is no experimental evidence which shows the changes in volume of leaner concrete. It is evident that the properties of the sand and rock become of increasing importance as their percentage increases. The tests by Schumann on volume changes in building stones, quoted at the commencement of this paper, show small values for limestones but variable values for sandstones, the upper figures being almost as high as those quoted for neat cement. Whatever the values might be for crushed stone as used in concrete, it is hardly conceivable that gravels and sands which have withstood the action of the weather for centuries without disintegration can change their volume much when wet and dried. It seems probable that in gravel concrete

the volume changes decrease as the proportion of cement decreases, until a certain lower limit is reached where the change in volume is purely a capillary phenomenon.

If this line of reasoning is correct those concrete structures should be most stable when exposed to the weather in which there is just sufficient cement to give strength but not enough to cause excessive volume changes. Practical experience apparently confirmes this view.

Stucco.—There are many instances where stucco has remained perfect even when exposed to the weather for half a century. There are probably more instances, especially in recent years, where stucco has failed miserably in five years. The excellence of old stucco is sometimes laid to the natural rock cement with which most of it was made. It is not safe to deny this on the evidence of a single experiment, yet attention may be drawn again to the one natural rock cement which has been tested in our laboratory, whose volume changes were in every way much greater than those of Portland cement.

Is it not more probable that the old stucco has survived because of its lower proportion of cement? When it was simply a question of providing a rough brick or stone wall, entirely durable in itself, with a smooth surface, and when in addition hydraulic cement was expensive, it was natural to use a mortar containing just enough cement to adhere to the wall. With the introduction of metal lath as the support for stucco, and the necessity of protecting the metal from corrosion, coincident with the drop in price of Portland cement came the use of richer stuccos.

The step was apparently an unfortunate one, for a volume change of 1 in. in 100 ft. as shown by the stucco 156 E as it changes from the wet to the dry state cannot but cause cracks. They may be only hair cracks, for with a crack every 12 ins. each crack need only be 0.01 in. wide to take up the whole change in volume. The elastic metal lath will probably yield without mechanical injury, but the protection against corrosion which the stucco is supposed to afford disappears with the first hair crack, and unless the lath has been better protected, by galvanizing or painting, than most sorts are by the manufacturers, its days are numbered. It would have been better to have used a leaner stucco and kept it free from cracks.

A stucco rich in cement may also split off in time from brick where a lean stucco would have remained good. The change in volume of brick when wet and dry is, according to Schumann, less than 0.02 per cent. If the change in the stucco is 0.08 per cent. there is opportunity for a stress corresponding to a volume change of 0.06 per cent. which might be 1,500 lbs. per sq. in. The fact that the stucco has not split off in one or two years does not mean that it may not split off in five or ten years.

Interior Floors.—The question of reinforced concrete is discussed in a later paragraph. Here only the changes in the concrete itself will be considered. The usual practice will be assumed in which there is a base of rather lean concrete covered with a wearing coat of mortar sometimes as rich as 1:1.

The first case assumed will be that of a cellar floor where the base is tamped down and the top coat at once put on, giving the best conditions for bonding. The whole mass gradually dries out and shrinks, but the top coat, because of its high content of cement, shrinks more. The top coat will tend to separate from the base, but since a cellar is always relatively damp there will probably be little trouble.

The situation is not so favorable when a top coat is to be laid on an upper floor of a concrete building. The main portion of the floor has been poured for possible three months and has already completed most of its shrinkage. Its surface is also probably dirty so that the freshly poured mortar will not readily unite with it. Both of these circumstances are unfavorable. The fact that the main portion of the floor has already dried out and shrunk causes an even greater differential shrinkage of the top coat. The advice is usually given to wet the floor thoroughly before pouring the top coat. It would be better to keep it wet for 24 hours beforehand in order to give it an opportunity to expand to somewhere near its initial volume.

It is not surprising if, under these circumstances, the top splits off the base, shrinkage cracks appear, and the individual slabs curl up somewhat at the edges in the effort to relieve the shrinkage strains. In case electric conduits, etc., are bedded in the top coat their course will be indicated by shrinkage cracks following the lines of weakness which they cause. Since these floors remain continually dry, conditions will become constant after a few months, and there will be little further change.

Sidewalks and Pavements.—The chief factor which influences the behavior of sidewalks and pavements is the weather. The influence of temperature is well known and will not be dwelt upon. A sidewalk usually consists of a base of rather lean concrete covered with a wearing coat of cement mortar which may be as rich as 1:1, and is not usually poorer than 1:2. The walk is cut into blocks and is sometimes provided with expansion joints.

As the walk dries out the top coat shrinks more than the bottom, as shown in the experimental study of compound bars. The effect can often be seen in sidewalks where the contraction has dished the entire slab so that shallow puddles of water stand in them after a rain. When the walk is wet by the rain the top expands more than the base. The alternate bending stresses thus developed all too often show themselves after a few years when the top coat splits off the base.

The necessity of expansion joints is now well recognized, although they are put in principally to take care of expansion due to changes of temperature. The experiments presented in this paper on both neat and sand briquettes indicate that the expansion of cements kept wet ceases at the end of a year, and that the total expansion does not amount to over 0.1 per cent. This would require a ¼-in. expansion joint every 20 ft. In addition there must be the joints to care for the expansion due to summer heat, which for a rise of 100° Fahr. is 0.05 per cent., about half of what may be expected from moisture. To take care of the volume changes from both these causes a ¼-in. expansion joint every 10 ft. should be adequate, although it does not include much margin of safety. In hot weather after a long rain these joints would be almost closed. In dry or colder weather they would be open.

According to the experimental figures any evils due to expansion should make themselves evident during the first two years, but practice does not always bear out this assumption. Reference was made at the commencement of this article to the cement walk laid around the campus of the University of Michigan twenty years ago, which is still showing expansion and giving mute evidence of the pressure generated by occasionally thrusting up two adjacent slabs in an inverted "V". This is not a phenomenon due to summer heat for it occurs usually in the spring. What is the cause which is still making this walk expand after twenty years?

An explanation may be suggested, although it is not possible to prove it completely. It is well known that the glass of thermometers expands when heated and contracts when cooled, but not to its original length except after a long lapse of time. Thermometers which are used frequently at

high temperatures keep growing longer. If they are laid away for a long period of time they shorten again and may even become shorter than when first calibrated. Metals behave similarly, so that it is not possible to utilize their expansion for making pyrometers which will not need frequent recalibration. The warping of the grate bars of fireboxes due to expansion is another illustration. It would be natural to expect analogy that concrete would tend to a permanent expansion when it is kept wet longer and oftener than it is dry, and that it would tend to become shorter under the opposite conditions. The experiments of this paper in general confirm this theory. Of the five bars of neat cement which had been kept under water for three years and were then dried out and re-immersed, all but one were longer after the re-immersion than they had been, and the one exception is apparently susceptible of explanation.

A more striking illustration is afforded by the two neat bars 146 A III. and A IV. These bars were made on the same day from identical materials, but after the initial measurement A III. was left in the air and A IV. placed in water. They were then alternated between air and water, at first at the end of each week and afterwards at longer intervals. There is, however, a definite difference in the treatment of the two, for with A III. each cycle has consisted of a period in air of two or three months followed by an immersion in water of usually a week. It has, therefore, been dry most of its life and its mean length since the end of the first month has been steadily diminishing. The companion bar A IV. was subjected to the opposite treatment in that its long periods were in water and its short periods in air. Its mean length and also its length when wet has been steadily increasing for the 18 months of its existence, although the rate of increase since the ninth month has been slow. At its last measurement it was slightly longer than another bar of the same cement which had been kept constantly in water, but it will require a longer time to decide whether the increase is material.

This theory of the continued expansion of cement walks in a rather damp climate, such as that of Michigan, is the only one which seems to adequately explain the compression ridges still occasionally developing in the twenty-year-old walk on the campus of the University of Michigan which has been referred to before. If the theory is correct it would indicate that there would be more trouble with cement sidewalks and pavements in wet countries than in those which are reasonably dry, and that there is need of much wider expansion joints in damp climates.

Reinforced Concrete.—It is evident from the data presented here that concrete undergoes a notable shrinkage as it drys. If a concrete beam is formed rigidly fixed at both ends, as is practically the case in skeleton concrete construction, it is evident that it must, on hardening, be under an initial tensile stress due to contraction. Conditions will not be changed by the presence of steel reinforcement provided the ends are absolutely rigid. If, however, the ends of the beam yield at all, and the concrete adheres to the steel, the strains will be adjusted between the two. The steel will be in compression and the concrete in tension, but to a lesser extent. In the review of the literature at the commencement of this paper attention was directed to the experimental work of Considere and to the experiments of Emerson, who found that even with mixtures as lean as those used in practice, compressive stresses of 2,500 lbs. per sq. in. might be developed in the steel through the volume changes in the concrete of bars only 3 ft. long and not anchored at either end. The paucity of information on this subject should be emphasized. There is every probability that there are important stresses in all reinforced concrete work due to volume changes in the concrete of which the designers have had no knowledge. These stresses may have been to blame for some of the collapses which have occurred in reinforced work, and the small number of such collapses may be more a tribute to the value of the factor of safety than to scientific knowledge.

It is encouraging to note, however, that in buildings, where the beams remain dry, most of the contraction will have taken place at the end of the first three months and that from that time on the volume changes will be slight. Concrete floor beams are treacherous during the first few weeks, not only because the concrete itself is new and weak, but because of the tensile stresses developed.

There is danger that a rather slight load on a green beam may cause cracking if not total failure, for it is entirely possible that the whole of the concrete is in tension and its tensile strength at that stage is very small. Several weeks should be allowed to elapse, even in warm weather, before the forms are taken off and the supports removed. Fortunately these tensile stresses seem to practically reach their maximum in three months, while the concrete gains in strength for a much longer period, so that if a concrete building is successfully completed there does not seem to be a probability of future failure due to changes within the concrete.

Causes of Change of Volume.—There is no experimental work to account for these volume changes. Their progressive nature as the cement hardens in water or air makes it evident that they are connected with the chemical processes of hardening. Since the hardening of cement is recognized as being essentially a process of colloid formation and change, it may seem not unreasonable to hold that the changes are connected with the volume of the colloid water. The nature of the volume changes as cement passes from the dry to the wet state is in harmony with this view. It is probable that the volume changes are also due in part to purely capillary phenomena, for sandstones and other building stones expand when wet and contract when dry. The amount of the expansion and contraction of concrete decreases as less cement is used, so that it appears that the changes are more a function of the cement than of the mineral aggregate.

The subject has not been sufficiently studied to show how far such factors in the manufacture of cement as chemical composition, temperature of burning, fineness of grinding, and rate of setting, influence the result; nor how far conditions surrounding its use, such as amount of water, temperature of air, etc., affect it. Until the influence of these factors has been determined it will not be possible to make intelligent progress towards lessening the volume changes and increasing the reliability of structures containing Portland cement. The subject is of such importance as to merit most thorough investigation from both the chemical and mechanical side on a larger scale than has yet been attempted.

Conclusions.—Concrete hardening in a moist place and remaining continually moist throughout its life expands slightly, but the compressive stress developed in the concrete is probably not large enough to be injurious.

Concrete hardening in air and remaining continually dry contracts. The contraction is roughly twice as much as the expansion of concrete continually damp. This greater stress is harmful not only on account of its magnitude but because it puts the concrete in tension, where it is weakest. It introduces an error of unknown magnitude into the calculations for all reinforced beams. It is responsible for the cracks in the top coat of interior cement floors. Fortunately most of the bad effects become evident within three months.

Cement sidewalks, pavements, and stuccos exposed to the weather contract when dry and expand when wet. The

richer the mixture is in cement, the greater is the volume change, so that there is a differential expansion between the top coat and base of sidewalks which is often sufficient to split the two apart. So also rich stucco may be split from brick. In damp climate irregular expansion occurs apparently for as long as twenty years. Its harmful effects may not appear for many years. Large expansion joints are necessary in sidewalks and pavements.

Rich stuccos will inevitably crack through expansion and contraction, and may be ruined. The few experiments made indicate that integral waterproofing compounds do not prevent or lessen the changes in volume. The only safety seems to lie in the use of lean mixtures whose volume change is slight. A stucco coat is inadequate as a protection for metal lath. If it is rich enough to keep water out it will crack. If it is lean enough to avoid the cracks water will go through it freely. In a dry climate the tendency is for sidewalks and stuccos to shrink more than they expand. Under these circumstances they will be much more durable, because of the slower corrosion stucco may be permissible as a protection for wire lath

AMERICAN IMPRESSIONS OF THE RISORGIMENTO BRIDGE AT ROME.

By Henry Grattan Tyrrell.*

Since the publication of my treatise on "Concrete Bridges and Culverts" in 1909, rapid progress has been made in the direction therein indicated, in the design of concrete bridges. Instead of the heavy masonry bridge with many piers, solid arch slabs and earth filling, practice has swung to the other extreme where reinforced concrete is used with individual members and outlines similar to those in steel, the framing in some cases being extremely light, as in the recent Mizenhead bridge in Ireland.

It is interesting to note that the world's record for a masonry arch, after the lapse of more than 2,000 years, is again at Rome. Pons Aemilius, (Fig. 1) which was completed 142, B.C., after undergoing numerous repairs, continued in use until 1890, when most of it was removed to make room for a new steel bridge with its deck supported on horizontal girders, the new structure now being known as Palatine bridge. Many of the old Roman bridges which were known as stone arches, were really only faced with stone, the body of the arch and piers in many cases being concrete; and the same system of construction was carried out in Roman buildings and other works. It is, indeed, known that concrete was much used many years before the Christian era, not only in Rome, but in Greece, Etruria, Assyria, India, and China, and it is also found in the Pyramids, the Walls of Babylon, as well as in the Great Wall of China. Occasional evidences of the use of concrete in bridge construction after the fall of Rome still remain, as in the bridge at Amalfi, Italy, built by the Moors in the sixth century.

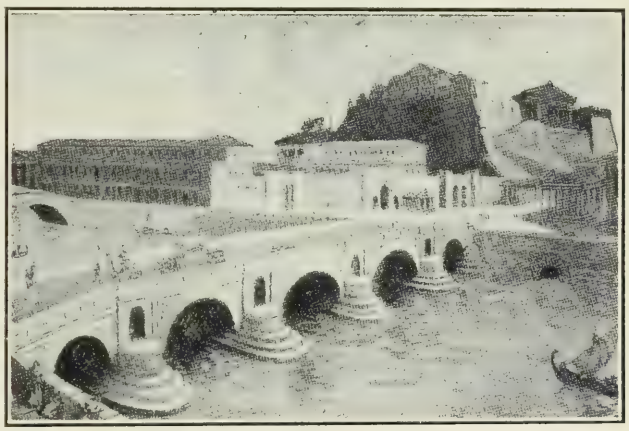

Fig. 1.—Pons Aemilius.

The Risorgimento bridge (Fig. 2) over the Tiber at Rome, with its clear span of 328 feet (100 meters) is in many ways a striking contrast to those adjoining it, and it is probable that if the old Roman engineer, Lucius Fabricius, who built bridges over the Tiber in the early part of the first century, could examine the latest one, he would likely view it with suspicion and disapproval.

The new bridge has a deck 65½ feet wide at a height of 47 feet above low water, and it crosses the Tiber with a single span. Compared with other concrete bridges, the next longest one Fig. 3) is at Auckland, New Zealand, with a span of 320 feet, and its deck 147 feet above water. In America the longest concrete spans are those at Larimer Avenue Pittsburg; Monroe Street, Spokane, and Detroit Avenue, Cleveland, with spans of 312 feet, 281 feet and 280 feet respectively. In Continental Europe the next longest concrete arch is that at Stein, Switzerland, over the Sitter River, with a length of 259 feet, (Fig. 4) though the stone arch at Plauen, Germany, has a span of 296 feet. In Great Britain, the longest concrete spans are those over the Nore River at Kilkenny, with a single opening of 140 feet, and a very flat rise, completed in November, 1910; and the slender foot bridge at Mizen Head, crossing the narrow channel to an island at the southwest extremity of Ireland, the length of span being 172 feet, and the deck 150 feet above water.

The most interesting features of the Risorgimento bridge are: (1) foundations, (2) flat rise, (3) hollow spandrels, (4) uncertain action, (5) surface treatment, (6) falsework.

(1) Foundations.—The chief requisite of an arch should certainly be an unyielding foundation. It has, in fact, become almost an axiom of design, that arches, especially those of small rise, are suitable only when such a foundation is obtainable, as at the crossings of the Niagara and Zambesi Rivers where rock cliffs rise on one side. Where arches are used on foundations other than rock, semi-circular ones, or forms nearly approaching to them are the best, and as the proportion of rise to span diminishes, the arch with its heavy lateral thrust becomes less desirable. The bed of the Tiber River, at the site of the new bridge, is composed of sand and clay underlaid to unknown depth with soft mud, necessitating pile foundations, covered with reinforced concrete grillage. This condition of subsoil would in itself, in most cases, lead to the use of shorter arch spans with greater relative rise, or to a girder bridge with only vertical reaction. Instead of heavy and massive abutments to resist the lateral thrust of so flat an arch, we find in the Risorgimento bridge, cellular construction with comparatively thin face walls backed up by seven 12-inch vertical walls, one of which is in line with each of the seven ribs on the bridge. There

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is no doubt that the builders of this bridge long experienced, long experienced in such work, and particularly with the "Hennebique" construction, were entirely competent to install these foundations which were on the "Compressol" system, and yet there is little question but that limited time and appropriation is responsible to some extent for the lack of more substantial abutments, such as used in many of the other "Hennebique" bridges.

Fig. 2.—Risorgimento Bridge, Rome.

(2) Flat Arch.—Arches with small rise are generally not a desirable form, for they not only have excessive lateral thrust, but they plainly display their weakness in this respect. The beautiful Alexander III. bridge in Paris, which is a model in almost every way, is lacking in this one particular, for it fails to impress the beholder with its strength and security. Its span of 353 feet is only a little more than the latest one over the Tiber. Since other bridges at Rome have one or more river piers, it would seem that at least two piers at this site would have been permissible and would have greatly decreased the horizontal pressure on the abutments, at the same time making arches with a greater relative rise approaching the proportion of the beautiful Trinity bridge at Florence, which for more than 300 years has been accepted as ideal. A rise of about one-quarter of the span gives a very pleasing proportion when it can be obtained, an excellent illustration being that designed by Alexander Nimmo at Limerick, known as the Wellesley bridge. The desire among engineers and designers for making bridges of record proportions is well known, and while this motive may not have been an influencing one on the Risorgimento, three spans would certainly have made a much better appearance.

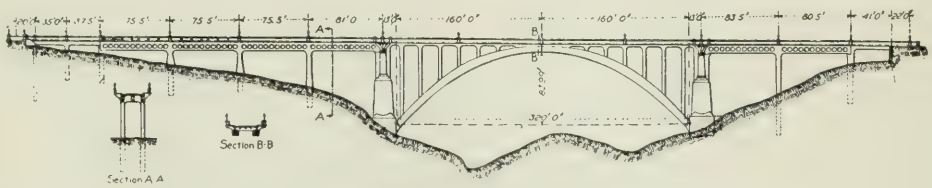


Fig. 3.—Crafton Bridge, Auckland.

(3) Hollow Spandrels.—The cellular type with hollow spandrels, which may be quite effective in the present case, is a violation of truthful construction, the general principle being that structures should, as nearly as possible, exhibit their real action and condition, and should appear to be just what they are. Concealment or deception should be avoided, and wherever consistent with construction, the general type and arrangement of parts should be evident. The accepted form in America for ribbed arches and open spandrel construction is to support the deck either on a series of spandrel columns, as in the Meadow Street bridge (Fig. 5.) in Pittsburg, or on longitudinal walls, as at Sandy Hill, over the Hudson (Fig. 6). For slab arches, the almost universal rule now is to use open spandrels with transverse arcades of colonnades. Lightness can as well be secured in these latter forms as in the more obscure and uncertain cellular type that was used in the bridge under discussion. The small thickness of the arch ring, varying from only 8 inches at the centre to 20 inches at the springs, contrasts greatly with the crown thickness of 48 inches and 72 inches on the Stein-Tuefen and Spokane bridges.

In the year 1896 Mr. Edwin Thacher made designs for two reinforced concrete bridges with hollow spandrels, enclosed on the face with curtain walls, one of the designs having a length of 150 feet. (Fig. 7). This resembles in some respects the Risorgimento bridge, and is one of the very few of this kind appearing in America. Unlike the Tiber River bridge, the American design showed only two longitudinal face walls, and those two were provided with expansion joints, making the stress conditions definite.

(4) Uncertain Stress Conditions.—Certainty of action and definite stress conditions are well known principles of bridge design. In the new Tiber River bridge with curved arch slab without hinges, rigidly connected to seven vertical ribs, it would seem that the stress condition was indefinite and the amount of thrust taken by the vertical ribs indeterminate. It is customary now, where a slab arch is used, to omit the vertical rib, or, if vertical ribs are used, to omit the slab. But the Tiber River bridge is a combination, and from the drawings which are shown in the reports of the "Ponts et Chasees" its action in this respect is indefinite. It is the practice in some bridges in America, notably those at Paterson and Clifton over the Passaic River, to make the arches continuous over the piers and anchor them securely back into the abutments, for the purpose of developing cantilever action. One of the first and perhaps most interesting experiments in this direction was that made by Brunel in 1836, when he erected a half cantilever arch of brick and cement at Rotherhithe when he was chief engineer of the Thames Tunnel. Brunel used no centering, the curve of the arch being formed by face moulds or sweeps. His experimental half arch stood on a 10-foot base, the long arm being 60 feet, while the rear or cantilever end was only 30 feet. The longer end had a rise of 10 feet 6 inches, and was balanced at the shorter end by a suspended anchor of about 31 tons. The upper and lower portions of the arch were 4 to 5 feet in width, while the spandrel wall was only 18 inches thick. He used hoop iron bands one inch wide and one-sixteenth inch thick, laid horizontally on the brick courses, and the strength of his experimental cantilever was proven by the fact that it continued standing for about two years. This interesting ex-

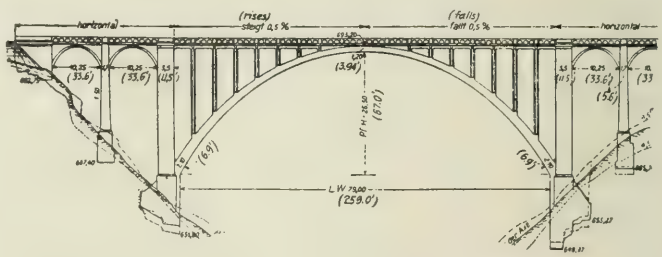


Fig. 4.—Stein-Teufen Bridge, Switzerland.

periment, which was probably the first of its kind, has been followed in more recent years by the construction of concrete cantilever bridges with members properly arranged for definite stress computation. While the Tiber River bridge was doubtless carefully designed, its stress conditions are certainly indefinite, owing to the combination of curved arch slab and vertical ribs, fastened rigidly together.

(5) Surface Treatment.—The surface treatment of the new bridge at Rome, with a fine flat face on the centre portion, resembling cut stone, and moulded blocks on the abutments, is excellent, being similar to that of the Sandy Hill bridge over the Hudson River, the Connecticut Avenue bridge at Washington, and the Chatellerault bridge over the Vienne (Fig. 8) built by M. Hennebique, 1899. In connection with surface treatment, it is interesting to note the efforts made in this direction since concrete bridges were first introduced. The Romans made extensive use of concrete in the body of their piers and arches, the surface being faced with travertine, their constructive methods being very plainly visible on the portion of old Ponte Rotto (Fig. 9) which still remains. The same system of construction was

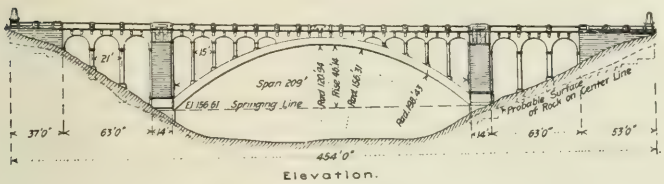


Fig. 5.—Meadow Street Bridge, Pittsburg.

extensively used on public works during the latter half of the eighteenth and the first part of the nineteenth centuries, but it was not until 1840 that a bridge was made almost wholly of concrete at Grisoles in France. It was the work of the eminent French engineer, M. Le Brun, who erected a span of 39 feet 4 inches over a branch canal of the Garonne. The only place where material other than concrete was used was in the exposed end of the arch ring, which was faced with brick, and the four vertical abutment edges below the springs, which were faced with stone. All other exposed surfaces, including the soffit and spandrels, were of concrete. Ten years after the completion of this little bridge,

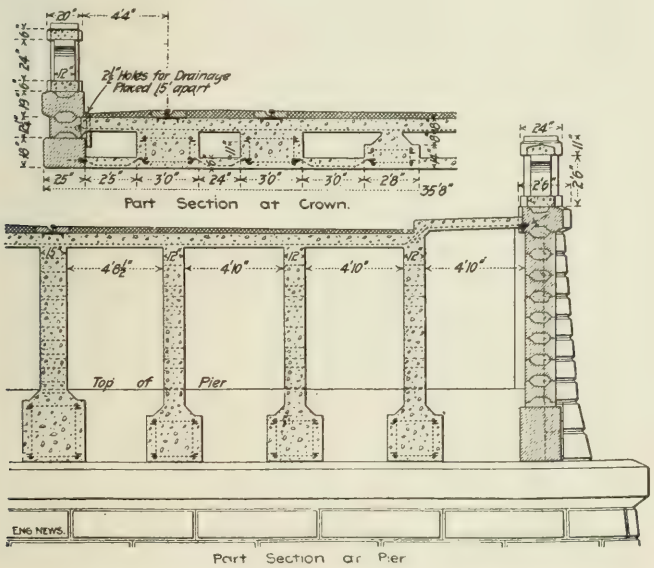


Fig. 6.—Sandy Hill Bridge, over the Hudson.

the building of the Grand Maitre Aqueduct in France was begun, the construction of which continued for fifteen years. The long series of arches, carrying the aqueduct was made wholly of concrete, the magnitude of the undertaking being hardly excelled by any later works. The surface finish on this aqueduct, however, was not satisfactory, for when concrete arches were again used in France about 1855, on many fine bridges, some of which are masterpieces of constructive art, they were faced with stone. These bridges include: Ponts au Diable, Notre Dame, Austerlitz, Arcole, Petit, Napoleon, Invalides, Alma. Experimental treatment of arch faces was again tried in 1868 when a 75-foot concrete span was erected near Gloucester Road station over the Metropolitan Extension Railway, London, the arch face being lined to represent ashlar. It was found that while bridges with concrete faces were aesthetic failures, they could be quickly built at small cost, and for several years following 1873 they were generally used by the Irish engineer Nathaniel Jackson in spans of 18 to 45 feet for highway crossings in the rural districts of Ireland.

The design of the Risorgimento bridge is lacking aesthetically, in that some prominent feature, such as pylons, statuary, or even lamp clusters, should appear above the deck over the springs, thus marking the limits of the arch and separating it from the abutments, but the absence of such features may be due to insufficient money appropriation.

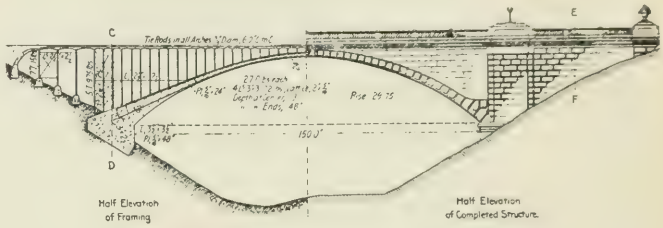


Fig. 7.—Proposed Bridge for Pittsburg.

(6) False Work.—The use of reinforced concrete false work in the Tiber bridge is interesting and unusual, and is reported to have successfully resisted the rapid autumn rise of twenty-four feet, and the additional impact of a drifting steamboat. The Tiber River is notable for its floods, having experienced no less than thirty disastrous ones since the building of the earliest bridges there. In recent times, an expedient has been used in some cases where maximum flood conditions were uncertain, in which the bridge has been designed and proportioned to resist water pressure when submerged, instances being those at Maryborough, Australia, and Paterson, New Jersey. The arrangement requires heavier construction, but permits the deck to be placed at a somewhat lower level, thereby eliminating expensive approach grades. As previously stated, the bridges over the Passaic River at Paterson have reinforcement continuous over the piers, which extends to the abutments for anchorage. The balustrades are made to be easily removed in times of flood.

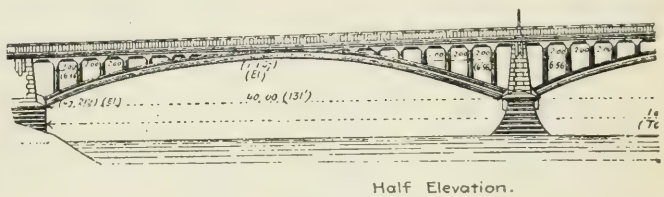


Fig. 8.—Chatellerault Bridge.

In reviewing the bridge as a whole, it is seen that the construction was carried out by representatives of the Hennebique Company, one of the most extensive builders of concrete structures in Europe. Ten years ago, their bridges were being built at the rate of one hundred per year, a record which can hardly be excelled elsewhere. The Saint Claude bridge over the Bienne, in France, with a span of 205 feet, and the well-known Chatellerault bridge over the Vienne were erected by this company. The first of these is a cellular type with springs at different levels, and built on a slight skew, finished about two years ago. It differs

from the Risorgimento bridge by having an open archway through one of its abutments, a feature which is very evident and characteristic. Compared with the next longest concrete arch span of 320 feet, at Auckland, New Zealand, these two bridges appear to be of quite opposite types, for the Tiber River bridge is all enclosed, while the Grafton bridge at Auckland is open. The New Zealand bridge has two reinforced concrete arch ribs hinged at the springs and crown, on which the deck is supported by means of spandrel columns, the whole construction being open for inspection.

Fig. 9.—Ponte Rotto, Rome.

The cost of $7.50 per square foot of floor surface for the Tiber River bridge is about the same as those at Walnut Lane, Philadelphia (Fig. 10), and at Sixteenth Street, Washington; and is quite as high as similar ones elsewhere, those at Auckland and Cleveland costing only $5.00 per square foot. The Spokane, Cleveland, Philadelphia and Washington bridges all have double arch slabs separated by a space of 12 to 16 feet, which is bridged at the floor level by the regular floor framing. The Chatellerault bridge in France, a ribbed arch of three spans, on the Hennebique system, cost only $3.00 per square foot of road, the cost in

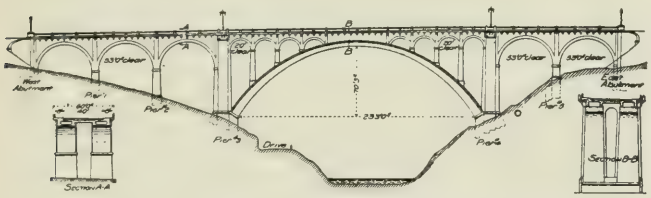


Fig. 10.—Walnut Lane Bridge, Philadelphia.

all the above cases being based on width of deck and extreme length rather than the length of opening. The Chatellerault bridge was completed in the remarkably short time of three months, while the Tiber River bridge, by the same company, occupied eighteen months, and the Grafton bridge at Auckland, about two years.

Notwithstanding its light proportions, the Risorgimento bridge withstood a remarkable test after completion, when seven steam rollers were passed over it, followed by wagons on which a large tree trunk was loaded, the whole being drawn by sixteen horses.

RAILWAY WAGES AND COST OF LIVING IN THE UNITED STATES AND EUROPE.

The Bureau of Railway Economics has completed the second of its comparative studies of railway conditions in the United States and the principal countries of Europe. This relates to the wages paid railway employees and the cost of living, and is based on the latest years for which comparative data are available.

The average daily compensation of railway employees of all classes for the year 1910 was in the United States, $2.23; in the United Kingdom, $1.05; excluding supplementary allowances negligibly affecting the average, it was in Prussia-Hesse 81 cents, and in Austria 89 cents. The lowest paid railway employee in the United States, the ordinary trackman, receives a greater compensation than many of the railway employees of France, even those of higher grades and with responsible duties. The compensation of railway employees is from two to three times as high in the United States as in Italy.

A recent report of the English Board of Trade on railway wages shows that the average weekly pay of enginemen in the United Kingdom in 1907 was $11.17; of firemen, $6.67. In the same year enginemen on American railways received an average weekly compensation of $25.80, counting six days to the week, and firemen $15.24. Recent returns make it clear that in 1912 enginemen and firemen in the United States are compensated at rates of pay for specific runs that are two, three and four times as high as the corresponding rates on representative English railways. The annual compensation of enginemen in the United States, as reported by two representative railway companies, now ranges from $1,100 in switching service to over $2,800 in passenger service, and of firemen from $700 in switching service to over $1,700 in passenger service.

For Continental Europe official returns in requisite detail are not available for a later year than 1908. The salaries and allowances of the typical engineman in Germany amounted for that year to $646.88, in Austria to $870.80; of a fireman in Germany to $424.59, in Austria to $532.03. The annual compensation of enginemen on two of the principal railways of France ranged in 1908 from $505.66 to $906.91, and of firemen from $324.24 to $595.98. In Italy enginemen received in 1908, salary and allowances included, from $581.10 to $812.70 a year; firemen, from $330.30 to $475.05 a year. In these Continental countries the maximum compensation is received after many years of service.

The average annual compensation of enginemen in the United States in 1908, on an estimated basis of 300 days' service, was $1,335; of firemen, $792. In this country the rate of compensation to these employees does not depend on length of service.

In Belgium enginemen received in 1907 from $23.16 to $38.60 a month; firemen, from $17.37 to $23.16 a month; conductors and station employees, from 46 to 96 cents a day. In the United States, in the same year, 1907, enginemen averaged, on the basis of 25 days' service, $107.50 a month; firemen, $63.50 a month; conductors, $3.69 a day; station employees, form $1.78 to $2.05 a day.

The rental of a three or four room house or flat is almost as high in Berlin, Paris or London as throughout the United States, but in England and on the Continent it generally runs from thirty dollars to ninety dollars a year less. The quantity of food and fuel estimated by the Board of Trade of England as the standard consumption of a typical workingman's family costs in the United States 17.8 per cent. more than in France or in Germany; 35.3 per cent. more than in Belgium, and 38 per cent. more than in the United Kingdom.

It is well within the truth to estimate in a broad and general way that while the cost of living of a railway employee in the United States is less than fifty per cent. higher than that of a corresponding employee in the United Kingdom or on the Continent, his compensation averages over twice as great.

DIESEL LOCOMOTIVE ENGINES.

In a lecture delivered before many of the engineering societies in the United States, Dr. Rudolf Diesel goes into the present status of the Diesel engine in Europe. One of the most interesting parts of his address is that dealing with the Diesel engine, as applied to the railroad locomotive. The following is an abstract of that section of the paper:

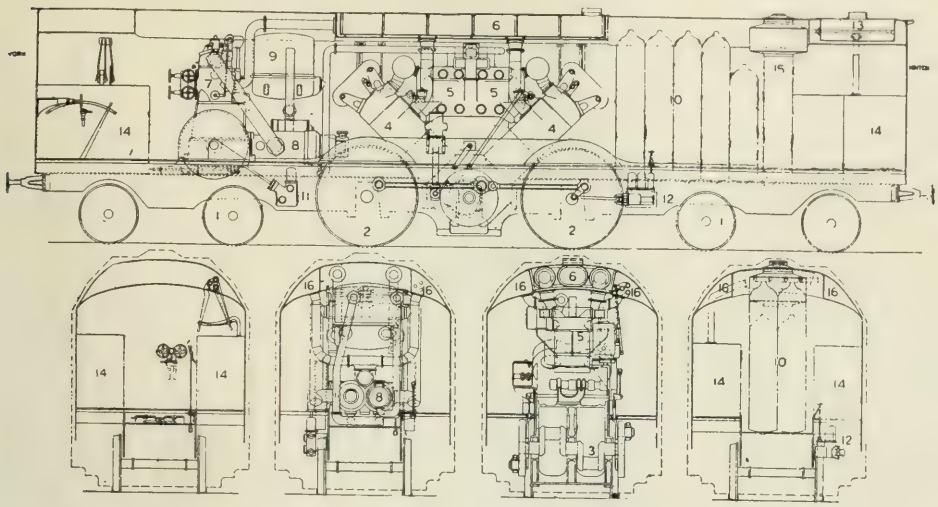


Fig. 1.—Diesel Engine Locomotive.

Of the Diesel locomotive nothing has as yet been published, and it gives the author a special pleasure to give a description of the first Diesel locomotive ever built, in this country of mighty oil wells and gigantic railways. From the early days of his invention the author was of the opinion that the special features of the Diesel engine would be of even greater importance for transport purposes than for stationary work, and, for that reason, the author devoted his time extensively to the development of the engine as motive power for transportation mediums. The author has already mentioned that he made the first small ship engine in 1902, and that since that time, the Diesel marine engine has been developed without interruption. The author further mentioned that he made the first automobile engine for trucks in the year 1909, and that he looks forward to the development of this branch within a few years. Finally, the author has to say, that he has worked for five years, together with Messrs. Sulzer Bros., at Winterthur, and Mr. Adolf Klose, of Berlin, on the construction of a Diesel locomotive, and that the first express train locomotive of 1,000 to 1,200 horse-power was finished a few weeks ago, and is now on the testing bed in the Winterthur shops. Five years is a very long time, and to explain why the work has lasted that long, the author must mention that the thermo-locomotive is the most difficult problem of construction that can be taken up in the way of modern engine building, not only on account of the difficulties in starting and manoeuvring with this special kind of motor, but also on account of the great limitations in space and weight. Compared with this, the development of the reversing marine motor has been relatively simple. Fig. 1 shows the design of this locomotive, the car of which was made in the renowned locomotive works of A. Borsig, at Berlin. It is 16.6 metres long over the buffers, and has two trucks of two axles each, 1-1, and two driving wheels, 2-2. The latter are not directly coupled with the engine, but indirectly with the blind axle (3) which is, at the same time, the crank shaft of the Diesel engine (4).

The Diesel engine is an ordinary two-stroke cycle engine, with four cylinders (4–4) coupled in pairs at an angle of 90°, and which drives the blind axle (3–3), whose cranks form an angle of 180° (see III–III). This disposition gives complete balancing of the moving masses, the first and most important condition when putting such engines on a movable platform. Between the working cylinders are placed two scavenging pumps (5) driven by levers from the connecting rod. Beyond the engine in the roof of the car is placed the silencer (6). On one side of the main engine stands an auxiliary engine (7). This latter consists of two vertical two-stroke cycle cylinders (7–7) coupled to horizontal air pumps (8–8) driven by these cylinders (see II–II). 9 indicates the cooler for the air compressed by these pumps. These air pumps serve, according to a special and patented process, to increase the power of the main engine when starting, manoeuvring and going up-hill, in such a way that auxiliary compressed air and auxiliary oil-fuel are conducted into the main cylinder, by which means the power is increased, making the engine as elastic as the steam engine. For the ordinary running of the locomotives, the main cylinders work like ordinary Diesel engines without the help of auxiliaries. To the right of the main engine is placed a battery of air bottles (10), the air from which helps the action of the auxiliary engine, and which can be refilled by the auxiliary engine at times when the latter is not used. Two pumps (11–12) provide for the water circulation in the cylinder jacket. 13 indicates an apparatus for the back-cooling of the water by evaporation, and 14, the tanks for fresh water and for fuel (see sections II–II and IV–IV). 15 is a small donkey boiler for the heating of the train.

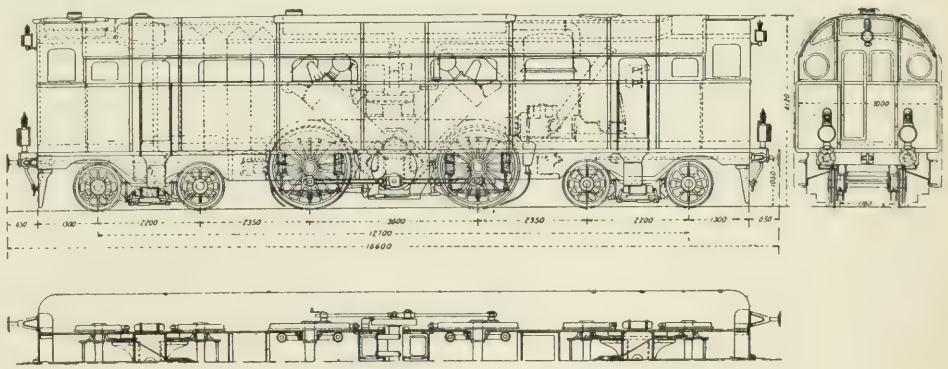


Fig. 2.

The whole plant is contained in a closed engine room which makes the locomotive look from the exterior like one of your steel cars. The canals (16) under the roof lead the fresh air to the suction pipes of the different motor and pump cylinders. The engineer can operate equally well on either side of the locomotive, as the engine is arranged for

running in both directions. He has a direct view of the track. Doors and platforms lead from the engine to the train. Total weight in service of the locomotive is 85 tons.

The author does not wish to predict whether or not this attempt at an entire revolution in the working of railways will be successful at once, or whether it must be repeated in modified form; but one thing seems certain to him: the Diesel locomotive will come, sooner or later, depending on the perseverance with which the problem will be followed.

Conclusion.—Before concluding his lecture the author desires to touch a very important question which has been put to him by the Secretary of the United States Navy, to whom he paid his first visit when coming to this country, and which has been repeated to him nearly every day since he left the pier at Hoboken: Why are we in America so far behind Europe in the development of this new prime mover, which in fact is no more new to-day?

To answer this question the author must emphatically state that the Diesel engines built in this country, after having passed the necessary manufacturing apprenticeship more than ten years ago, have been and are quite as good as the European machines. So the question is not a technical one, but merely a commercial one, or even more one of the general economical conditions of this country. The author does not know the United States sufficiently to judge these conditions on his own behalf, but he has tried to find out, in his conversations with many prominent engineers, and the following is what he could learn:

First.—Coal is much cheaper than in Europe, and, therefore, people are more wasteful with it; while the leading idea in Europe is always the economy in operating cost, the leading idea in America is economy in first cost. The word efficiency, which is the base of every contract in Europe, seems to be unknown to a vast proportion in this country. Of course, not to engineers, but to business men and to purchasers of engines.

Second.—Steam engines are much cheaper in America than in Europe, but the Diesel engine is not and will not be a cheap engine; it aims to be the best engine and must be constructed of the very highest class of material, with the best tools and by the most skilled workmen; this makes it difficult for it to compete when such ideas prevail.

Third.—Another general reason seems to be, in very many cases, the lack of capital of the prospective purchasers, and also, the higher rate of capital interest prevailing in the American money market.

Fourth.—A further reason is this: that in the last few decades the general business profits have been so big, that people did not care for the most economical methods of production and for the strictest economy in the fuel bill, as well as other expenses,—the ruling object having been to manufacture quickly and in quantities, without much regard to the cost. American industries had not, as those of Europe, to compete with the industrial countries of the world. The author has been told by American engineers that what has happened with the Diesel engine, has also exactly happened to the large gas engines, especially with blast furnace gases, and also with the steam turbine, both of which have been taken up in this country long after the development in Europe. The same has also happened with the by-products of coke ovens. Even to-day, the wasteful beehive oven is in use, while in Europe the industry of the valuable by-products earns hundreds of millions every year and has had the tendency to keep the prices of the natural liquid fuels on a lower level.

All the conditions the author has alluded to seem to be changing rapidly now; this terribly wasteful performance begins to be realized, the competition has become more keen, and a conservation of natural resources is striven for more than ever before. If this is true, the high-class engines with the highest efficiency will begin on this side of the ocean to have the same importance as abroad.

In conclusion the author expresses the hope that he has given a true and clear picture of the development of the Diesel engine in old Europe, with a few reminiscences of the pioneer work in America, and finally wishes to call to his hearers' minds the fact that nowhere in the world are the possibilities for this prime mover as great as in this country.

THE ELECTRIFICATION OF STEAM RAILWAY TERMINALS.*

By W. F. M. Goss.†

A proposition involving the complete electrification of steam railway terminals in any considerable city constitutes a problem which touches closely the comfort and welfare of the community involved. It is conceivable that through electrification the beauty and cleanliness of a city may be so affected as to stimulate greatly its prosperity and growth, and it is conceivable also that through electrification a burden of financial responsibility may be created which will place severe limitations upon its commercial and industrial development.

The city of Chicago presents at the present time an area of 194 square miles, which is cut up by 2,600 miles of railway track. The Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals of the Chicago Association of Commerce, in the study of its problem under the immediate direction of Mr. Horace G. Burt, has thought it wise to add certain areas so as to include outlying transportation lines correlated with those within the city limits. The area thus defined, which is known to the committee as Zone B, embraces 235 square miles and contains about 4,000 miles of railroad track. It is estimated that 60 per cent. of this track mileage is in yards, sidings, freight and passenger terminals and industrial tracks. The remainder is in main or running tracks. In the language of Mr. Burt, "There are within the city limits 105 separate railway yards and there are many junction-points of intersecting track where an enormous volume of through and local traffic is daily interchanged and handled." A map of the city shows its railway yards to be spotted over its entire area.

If it were true that the electrification of Chicago railway terminals would at once banish smoke from the atmosphere of the city, certain important unknowns in the general problem would be eliminated, but it happens that there are in Chicago other smoke and dust-making agencies besides the 1,600 locomotives which are required to operate its railroads, and the percentage of the whole that is contributed by its locomotives is not known.

Chicago more than most cities can boast of the number and significance of her metallurgical, manufacturing and other industrial fires, not all of which are smokeless. Statistics show that within the city are 17,000 steam boilers served by nearly 10,000 stacks. Thousands upon thousands of domestic fires warm and otherwise serve the homes of this city, and these are not all smokeless. Even the motor cars

* Abstract of a paper read before the City Club of Chicago.

† Dean and Director, College of Engineering and Engineering Experiment Station, University of Illinois.

of Chicago add their quota of smoke, and the wasting of their tires their quota of dirt. It may be that the railways' proportion is, after all, not large, and that the complete abolition of this portion through electrification, or otherwise, would result in but little change in the atmospheric conditions above this city. This is one of the phases of the general problem to which the committee of the Association of Commerce, to which I have already referred, has properly directed its attention. . . . So perfectly have the plans been laid and so scientifically are they being developed that it is easily possible to foresee an accurate determination of a percentage of the total pollution which is chargeable to railway operation. . . . If it should appear as a result of this investigation that the atmospheric conditions of Chicago would be materially improved by the prohibition of the steam locomotive within the city limits, the people of Chicago will be justified in desiring most strenuously such a consummation.

There are many indications of an assumption on the part of the people that the only sure way to secure the elimination of locomotive smoke is through electrification. It appears that the validity of this assumption has not been conceded by the railways. . . . If it should appear after a thorough investigation, such as is now being made under the direction of the Association of Commerce, that the railroads are, relatively speaking, not large producers of smoke, and if it should appear that further reductions in the amount of smoke they produce are practical, the arguments to sustain a change would be materially weakened.

In the meantime, other interests in the field propose the substitution of storage battery locomotives for the existing steam locomotives. They enforce their suggestion with the argument that such a change could be made at a cost which would be comparatively small, and that while the change would add to the cost of operation, it would not involve any serious change in operating conditions. Again, the recent visit to this country or Dr. Rudolph Diesel, the originator of the Diesel engine, has stimulated in many quarters an interest in the possibility of developing a locomotive of the motor-car type which will be operated through the action of a Diesel oil engine, an internal combustion machine of high efficiency. The Diesel engine commonly uses crude oil as its fuel, but other forms of combustible liquid may be employed. The field of application of these engines has been rapidly extended in recent years. Their use in marine service has been extremely successful, and Dr. Diesel has himself developed in Germany a Diesel locomotive of a thousand horse-power. The adoption of such a locomotive for the terminal work of the railways of Chicago might result in the complete elimination of smoke and dirt, and it is believed that while it would add to the expense of existing operations, as would the storage battery locomotive, it would not greatly disturb present conditions, and the expense of the change would be small as compared with that of general electrification.

It is apparent from these statements that, if brought to the issue, the railways may prefer to adopt some form of terminal operation, which, while entirely meeting the objections to existing practice, will not involve the complete electrification of the city's railway terminals in the large sense in which that term is being used.

The general problem of electrification presents two aspects, the characteristics of which are, to my mind, wholly different. These are, first, electrification as applied to suburban passenger traffic, and second, electrification as applied to all other traffic, including, of course, switching, through freight and through passenger service. In the working out of details, these two phases may, of course, be regarded as a single problem, but the considerations which may be set forth as justifying development are not the same in both cases.

The simpler phase of the problem is that which involves the suburban passenger traffic. Every detail which enters into this problem has been threshed out by extensive construction in many parts of the country. The experience which has been gained in the electrical operation of elevated railroads in Chicago, in the electrical operation of the subways in New York and Boston, and in the extensive electric operation of interurban roads in many parts of the country, bears directly upon this aspect of the problem. Among the advantages which the public would derive from electrically operated suburban service in the city of Chicago may be counted that of reduced atmospheric pollution, of cleaner cars, of freedom from inconvenience due to the presence of smoke and cinders, and probably also that of more frequent and more rapid service. The operating railway companies would find some gain in an increased capacity of existing track facilities, in the incidental advantages which would accrue from the maintenance of a more attractive and a more effective service, and in the anticipated gain in business which the improved service would in time attract. There are no real difficulties in bringing about such a change, except such as grow out of the fact that the railroads are now equipped for steam operation. To electrify means that the existing steam operated railways which are earning dividends for their companies must practically be wiped out of existence, and new railroads built and equipped to conform with other standards of practice must be supplied. Very little of that which is now possessed, excepting the track and track structures, and possibly, though not probably, the car bodies, could be of use under the new conditions. Everything electrical, such as power plants or their capitalized equivalent, transmission and distributing lines, new cars or trucks for cars and repair shops in which the new equipment can be kept in order, must be supplied. While I am not authorized to speak for the railroads, I imagine that the difficulty is not that the cost of these things, so far as they apply to suburban service, is prohibitive, but that there is no immediate way by which existing revenues can be materially increased as the result of such a change, and because present-day directors and present-day stockholders are content with what they have. The considerations controlling the financial aspect of the matter are somewhat similar to those controlling the matter of track elevation. The progress of track elevation places heavy burdens on the railroads affected, for which the immediate return is slight, but the work once accomplished raises the character of the railway establishment to a higher standard of construction, and permits its operating service to be gradually tuned up to higher stages of efficiency. The electrification of suburban service in Chicago, while hedged about by similar difficulties, would lead to similar beneficial results, and in the absence of a plan which might insure immediate and complete electrification, it is reasonable to expect the gradual development of suburban electrification.

The complete electrification of Chicago steam railway terminals constitutes a problem of far greater proportions. As already noted, such a development would, as set forth by Mr. Burt, spread over an area of 235 or more square miles, would need to deal with approximately 4,000 miles of track and perform a service which now involves the use of 1,673 steam locomotives apportioned as follows:

To yard service	555	33 per cent.
To through passenger service	367	22 " "
To road freight-train service	364	22 " "
To suburban passenger service	208	12 " "
To freight and passenger transfer service	179	11 " "

If accomplished, it would give the public of Chicago the most marvelous railway terminal that the world has ever seen. The difficulties are not technical, but chiefly financial, and the problem of financing such an undertaking is not one which can be unceremoniously dumped on the railways, for the interests of the railways and of the community served by them are more or less identical, and neither can afford to ignore or injure the other. Probably no one knows the first cost of such an improvement, nor what its effect would be upon the earning capacity of the railways. Those who are especially qualified to speak on this subject are not talking. The Association of Commerce committee, to which I have referred, will have all the facts later, but no figures have as yet been given out.

Some conception of the manner in which expense arises can be gathered from the following very crude illustration: The first cost of a modern steam locomotive may be taken as $20,000. An electric locomotive of the same power will cost about twice as much, but the electric locomotive, unlike the steam locomotive, is not in itself a power unit. It can only be effective in doing work when there is somewhere available a power plant from which it may be supplied with current, and the cost of that portion of the power plant which is chargeable to a single electric locomotive will be a rather large percentage of the total cost of the steam locomotive. Between the electric locomotive and its power plant must be a labyrinth of electric feeders, numerous expensively equipped substations, trolley wires and substantial structures for carrying them, or, in the absence of these, a third rail and all the complicated equipment necessary to transmit the current from the plant to the electric locomotive in whatever location it may occupy on the track. Moreover, in entering upon any large scheme, such as that of complete electrification, many incidental matters arise, the cost of which, while not directly chargeable to electrification, goes to swell the total cost for the whole improvement. By the end of another year the Association of Commerce will, it is hoped, be ready with an estimate based upon an extensive research which will be entitled to the confidence of all parties in interest. The public can well afford to reserve its judgment until the committee's work is completed.

Not only must the railways consider the charges incident to the first cost of electrification, but they must be prepared for some increased cost in operation. Contrary to a commonly expressed popular conception, the actual movement of a train of cars from one point to another upon the terminal railways of Chicago can probably not be accomplished more cheaply electrically than by steam. Again, in the through train service, the electric operation of Chicago terminals would not reduce cost. Under present conditions, through trains approaching Chicago from a distant division point are brought directly into the city by their steam locomotives. The electrification of the terminals would involve the withdrawal of the steam locomotive and the attachment of an electric locomotive at a terminal located at the boundary of the electrified zone. Assuming no electrification, the additional cost of fuel and of service of the steam locomotive crew for taking the train on to its Chicago terminal, as compared with the costs entailed where the locomotive gives up its train outside of the city, is so small as to be almost negligible, while with electrification each train must bear its share of the cost of the electric service which receives it at the boundary of the zone and takes it into the city terminal; that is, electrification would make two operating divisions where one now exists, and short divisions are expensive to operate. There are many other minor difficulties and there are also minor advantages which are revealed by an analytical study of the problem, but excepting in the one matter of smoke and dirt elimination, the advantages in Chicago, where there is no operation in tunnels, are all minor advantages.

Not all of the forty railroads entering Chicago are prosperous. It would be extremely difficult for some to secure the capital necessary for the complete electrification of their Chicago terminal by the sale of securities constituting a lien upon property extending out over the country and through other insistant cities. Compulsory electrification as a measure for immediate execution would add to their present embarrassment and could hardly fail to work to the ultimate disadvantage of the business interests of Chicago.

Here it will be well to note that no great scheme involving the electrification of steam-operated lines, has ever been voluntarily entered upon by a railway company merely for the purpose of raising the character of its service from the conditions of steam operation to those which become possible through electric operation. Where electrification has been undertaken there has always been some large business purpose of interest to the railway company, in the working out of which electrification has entered more or less as a detail. For example, in New York City, the New York Central Railway was operating a long series of tunnels into its Grand Central Station. Its traffic had increased until the frequency with which trains passed kept these tunnels filled with smoke and steam. Operation became increasingly difficult, until an accident in which many lives were lost, resulting from the inability of an engineer to see the signals as he passed them, convinced the railroad officials that a change in operating conditions was necessary. In this case it was a question of giving up the Grand Central Station or of resorting to electricity. The great purpose was to preserve for the railway a valuable terminal property, and electrification proved a ready means to such an end. Similarly, the Pennsylvania Railway entered upon an extensive scheme of terminal improvement, involving a new station in the midst of Manhattan, where before no station had existed, a rail connection with the roads of Long Island which previously had constituted an isolated railway system, and the operation of tunnels under two rivers and a great city. The purpose was not primarily to electrify, but to gain a great terminal, and in the development of this purpose electricity entered as a desirable detail.

It would seem that the City of Chicago, instead of insisting upon the complete and immediate electrification of its steam railway terminals as they now exist, would do well to study carefully in conjunction with the railroads, perhaps through the instrumentality of a commission having large powers, the whole terminal problem. Such a commission could work out in a large way a development adequate to future needs. It could rearrange and simplify existing tracks, it could combine and extend existing terminal stations, it could consider every factor affecting the efficient movement of cars and the transfer of merchandise and passengers from railway terminals to destination. The working out of such plans might be expected to give not only increased facility, but also reduced cost in operation. Such a procedure, covering all of the transportation interests of Chicago, would constitute a stupendous undertaking, but nothing less can satisfy the real requirements of this great rapidly-growing modern city. The working out of any large scheme of terminal betterment, which can be justified as an economic measure, would at once provide an opening through which electrification as a detail could be, and probably would be, readily admitted.

AN ELEVATED CONCRETE TANK.

A tank constructed of reinforced concrete with a capacity of 100,000 gallons, has been erected recently for the Chicago City Railway Company Car Shops, at Seventy-Eighth Street and Dincennes Avenue, Chicago. The tank will provide fifty pounds pressure on the mains of the sprinkler system of the shop. It rests on columns 75 feet high and has a double dome bottom.

Built for auxiliary water storage to supplement the existing 1000-gal. per minute motor-driven underwriters' pump taking water from the city mains, the water in the tank will feed into the system, when the normal pressure, 90 lb. per square inch, maintained by the pump is reduced to 50 lb. per square inch. The underwriters' pump starts automatically and, to insure its constant readiness to serve, a few taps in the shops are connected to the sprinkler service mains. Ordinarily the pump starts every three hours. It is estimated the tank will supply four 1¼-in. nozzles for four hours. There are many acres of buildings, including the barns which house each night cars valued at $2,000,000. As to the choice of materials, the engineers estimated the cost of painting a steel tank with the attendant danger of fire each year while it was out of service would be about one-third of the difference between the first costs of steel and reinforced concrete tanks.

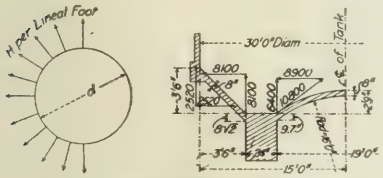


Fig. 1.—Calculation Diagrams.

In designing the tank the shell was made 8 in. thick although the engineers claim they would use 6 in. if another were built, as 4 in. is used in German practice and only this thickness is required by the calculations. Greater thickness, they hold, only weakens the structure by the additional load. Each horizontal ring is reinforced to sustain itself from bursting pressure in the usual manner. A heavier section is used at the top to contain sufficient steel to care for the domed roof. This form was used to eliminate beams, and for drainage purposes six holes opening into the tank are left at the periphery.

Two domes, as shown in the accompanying drawing, make up the bottom of the tank. The sizes are so proportioned that the horizontal thrusts over the supporting circular girder are approximately equal and opposite. The outward thrust of the inverted concentric dome at the base of the shell is cared for by an enlarged concrete section reinforced for these horizontal stresses. The methods used by the engineers in calculating the more unusual features of the tank are given below.

The roof is a section of a sphere, which is 30 ft. in diameter and 3 ft. high, and weighs approximately 58,000 lb. The shear per lineal foot at the base of the dome is $S = wd^2\pi/4 \div \pi d = wd/4$. This shear or vertical reaction is divided into two components, the horizontal tension H and the thrust T. Graphically, we obtain $H = 2.4\ S = 0.6\ wd$ and $T = 2.6\ S = 0.65\ wd$, or substituting $w = 70$ lb., $d = 30$ ft., then $S = 525$ lb., $H = 1260$ lb. and $T = 1365$ lb.

The component H produces a ring action at the base of the dome as shown in Fig. 1, and the tensile stress on the reinforcing is $Hd/2 = 18{,}900$ lb. The area of four ⅝-in. square bars is 1.33 sq. in. and the tensile stress is 18,900 ÷ 1.33 = 14,200 lb. per square inch.

The shearing stress per square inch on the concrete at the base is 525 ÷ 48 = 11 lb. The compressive stress at the base is 1365 ÷ 48 = 28.4 lb., or a factor of safety of at least 40 for the dome proper.

The vertical load per lineal foot at the base of the shell due to the weight of the shell and roof is 2520 lb. This force may be divided, as shown in Fig. 1, into two components, a horizontal tension on the ring and a thrust on the inverted dome. The angle being 45 deg., the tension per lineal foot is 2520 lb., and the thrust per lineal foot is $2520\sqrt{2}$ or 3560 lb. The stress on the ring reinforcement having an area of 2.65 sq. in. is (2520 × 30.67/2) ÷ 2.65 = 14,600 lb.

The inverted dome is subject to tension in a horizontal direction from the water pressure and is figured accordingly. The top of the dome is subject to a vertical shear of 2520 lb. per lineal foot and to a compression of 3560 lb. per lineal foot, or a shearing stress of $2520 \div 12 \times 8 \times \sqrt{2} = 18.6$ lb. and a compressive stress of 3560 lb. ÷ 12 × 8 = 37.1 lb. The weight of the inverted dome, by Guldin's rule, is $6 \times 2/3 \times 144 \times 27\pi = 50{,}000$ lb. The weight of water on inverted dome is $(30^2 - 23^2)\ \pi/4 \times 20.5 \times 62.5 = 292{,}000$ lb. The total shear at the base of the inverted dome equals the weight of the roof, the shell, the dome and the water on the dome, or a total of 586,000 lb., and per lineal feet 586,000 ÷ 23 π = 8100 lb.

This shear or vertical reaction may be divided into two components, as shown in Fig. 1, a horizontal thrust in the ring girder and a thrust on the inverted dome. The angle being 45 deg. the thrust on the dome is $8100\sqrt{2} = 11{,}450$ lb. per lineal foot. The shearing stress per square inch is $8100 \div 12 \times 8\sqrt{2} = 60$ lb. The compressive stress per square inch is 11,450 ÷ 12 × 8 = 120 lb.

The sphere has a radius of 16 ft., and the section of the sphere forming the dome a diameter of 19 ft. and a rise of 2 ft. 9 in.

The weight of the dome is approximately $19^2\pi/4 \times 1.1 \times 100 = 31{,}000$ lb. The weight of the water above it is $19^2\pi/4 \times 20 \times 62.5 = 355{,}000$ lb. and the vertical shear or reaction at the base per lineal foot is 386,000 ÷ 19 π = 6400 lb. This force may be resolved into two components, as shown in Fig. 1, a thrust on the ring girder nearly counterbalancing the thrust from the inverted dome, and a thrust of 10,800 lb. per lineal foot on the dome.

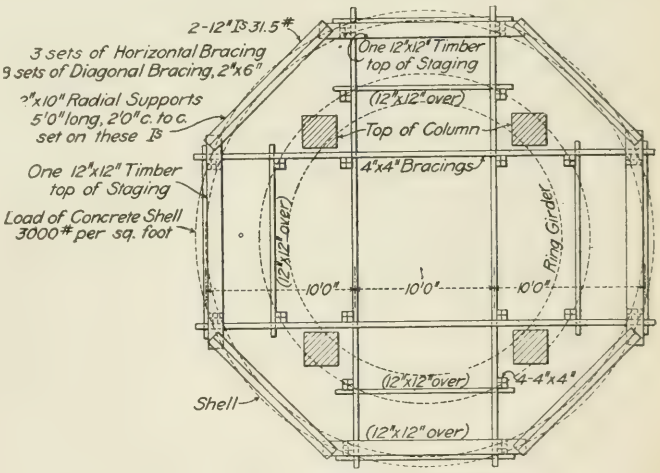


Fig. 2.—Plan of the Top Staging.

The shearing stress per square inch is 6400 ÷ 12 × 9.7 = 55 lb. The compressive stress per square inch is 10,800 ÷ 12 × 8 = 113 lb., showing also an unusually high factor of safety.

In calculating the ring girder supporting the tank structure it was assumed that the portion of the load over the columns was carried directly. The girder was then figured as a continuous beam with supports assumed 13½

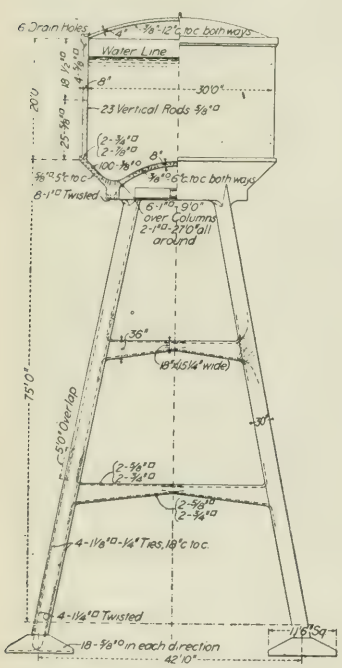
ft. apart. Bending moments of the straight line span were compounded with the torsional moment.

While stresses in the circular girder as soon as construction was completed are held to be vertical only, the weight of the green concrete in the inclined columns produced four inward thrusts on the ring. To care for these stresses concrete struts in the form of a cross connected the tops of the columns.

Assuming a force of 50 lb. per square foot on a flat surface, the total force of the wind on the round tank is 31 × 27 × 50 × ⅔ = 28,000 lb. The assumption was made that each of the two bents in one direction takes care of half this force or 14,000 lb. On account of appearances and the fact that the structure was built over an existing building, diagonal bracings were omitted, and each bent was figured as a nine times indeterminate structure.

The omission of the diagonal bracings caused bending moments in the horizontal ties and in the columns. These bending moments are greatest at the joints of ties and columns, and practically zero in the centre of the ties. The weight of the columns and ties amounts to 302,000 lb.

The direct compression from the wind at the base of the column is 14,000 × 84 ÷ 42 = 28,000 lb. The greatest load on one column is 409,000 lb. and the greatest direct stress 409,000 ÷ 900 = 454 lb. per square inch, which is increased by 390 lb. from the bending moment due to wind stresses on account of the omission of diagonal bracings, neglecting the reinforcement.



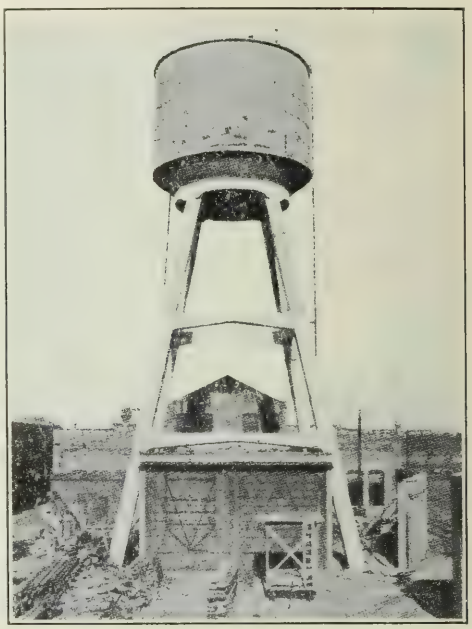
Elevation of Standards and Part Section Through Tank Showing Reinforcement.

Foundations for the legs were carried down to solid, comparatively dry, blue clay which required picking to loosen it. To the casual observer there is such a batter to the legs that sliding on the foundation would seem to be considerable, but the calculations indicate it is a negligible factor and the provision for bearing stresses, amounting to 2.9 tons per square foot, was the governing stress. No measurable settlement could be detected by leveling on the bench marks placed in the concrete legs before and after filling the tank with water.

Six-inch inlet and outlet cast-iron pipes are imbedded in two of the legs. It is believed they will be sufficiently insulated from frost by the concrete, but in addition a 2-in. steam pipe parallels the water pipe, rises 3 ft. into the tank and returns down the other column alongside the second water pipe. By the circulation of steam through this pipe it is hoped to prevent the formation of ice in the tank.

A check valve, protected by gate valves on each side ordinarily kept open, is placed on the connection to the high-pressure mains. An altitude gauge indicates the elevation of the water and a 2-in. tell-tale overflow pipe imbedded in one of the legs discharges on the ground near the outlet pipe manhole when the water is within 3 ft. of the top of the tank, at the 100,000-gal. level.

To support the form work a staging in the shape of a maltese cross was erected on top of the outer and partition brick walls of the kiln house. Six series of 8 x 16-in. timbers were laid on edge transversely over the walls and on these twenty uprights, 46 ft. long and made up of four or six 4 x 4-in. sticks, were erected. These smaller timbers were all in 18-ft. lengths as they had come from another job. Holes for the clamping boards over the butt joints were bored with electric drills and the timbers assembled and bolted up in 3 days by 3 men. While the uprights were assembled in the shop they were knocked down and subsequently erected in 18-ft. lengths by means of a gin pole and a hand winch. There were 3 sets of horizontal bracings of 4 x 4-in. timber and 8 sets of diagonal bracings of 2 x 6-in. lumber.



View Showing Elevated Concrete Tank.

Vertical supports for the shell ring form consisted of 2 x 10-in. Y.P. No. 1 planks, 4 and 5 ft. long, placed on end radially, 2 ft. apart. Fig. 2 shows the support for these radial planks. The 12-in I-beams across the corners rest on top of the 12 x 12-in. timbers laid over the uprights. Three weeks after the concrete had been placed some apprehension was felt on the part of the engineers when three of these radial supports were accidently knocked out. An examination of the remainder disclosed the fact that there was a space of 1/16 in. between their tops and the forms due, it was thought, to the shrinkage of the concrete which would cause rotation around the circular girder and also to a slight shrinkage of the staging which had been exposed all winter.

Concrete for all parts of the work except the foundation was a 1:1:2 mixture of cement, torpedo sand and 1-in. gravel. On account of the intricate framing the contractor concluded it would not be feasible to use wheelbarrows or spouts so a double elevator carrying 8 buckets of concrete on each platform was erected at one side and operated by a team of horses.

Mr. L. J. Mensch, of Chicago, designed and constructed the tank for the Chicago City Railway Company, M. H. B. Fleming, vice-president and chief engineer. The designs were checked by Mr. Hugo Schmidt, superintendent of buildings of the railway company, under whose immediate direction the work was carried out.

The Canadian Engineer

ESTABLISHED 1893.

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COAL IN CANADA.

The second volume of a series of six on an investigation of the coals of Canada with reference to their economic qualities, has just been published by the Mines Branch of the Department of Mines of Canada. This investigation of Canadian coals and lignites was begun about six years ago. At that time Dr. A. P. Low, Director of the Geological Survey, undertook a study of the fuels of the Dominion somewhat on the lines of the fuel tests which had already been commenced by the United States Geological Survey. The Government, however, had not, at Ottawa, any suitable mechanical laboratory. The Mining Department of McGill University possessed suitable equipment, and the work was, therefore, assigned to Dr. J. B. Porter, the head of the Mining Department there. Shortly after the commencement of the investigation the Dominion Deparment of Mines was created, with Dr. A. P. Low as Deputy Minister; and the investigation, together with all matters relating to economic minerals, was transferred from the Geological Survey to the Mines Branch under the directorship of Dr. Eugene Haanel. The original arrangement, however, was in all respects continued without change. It was intended originally to confine the investigation with coals and lignites of the Dominion; but owing to limited means the following points only were covered: Sampling in the field, crushing the samples and preparing them for treatment, washing and mechanical purification, coking trials, steam-boiler trials, producer and gas engine trials. chemical laboratory work and miscellaneous investigations. The technical staff engaged in the operation comprised Dr. J. B. Porter, Prof. R. J. Durley, Mr. Theo. C Dennis, Mr. Edgar Stansfield, and a large staff of trained assistants.

As was noted above, the results of the investigation will be published in six volumes, of which the second has just come to hand. A very large amount of information has been gathered for the report; much of it, however, is so highly technical as to be only of interest to specialists, hence it has been thought best to divide the report into two main sections of two and four volumes, respectively.

It was the Government's intention to compile and publish a report covering the whole field of the coals of Canada which would be of interest, not only to the engineer, but to the layman, and which would place on record all the facts possible regarding the economic value of Canadian fuels. The results, as seen in the first two published volumes, reflect great credit to the Mines Branch of the Department of Mines, who superintended the investigation, and to the Mining Department of McGill, who conducted a great portion of it.

The succeeding volumes will be awaited with interest, and, when complete, we are satisfied that this investigation will stand as an authority on the subject for many years.

AMERICAN WATERWORKS ASSOCIATION.

The American Waterworks Association has just finished its thirty-second annual convention in Louisville, Ky., and as usual the meeting has been replete with most instructive papers and interesting discussions. This year a Canadian, Mr. Alexander Milne, superintendent of the Waterworks Department of St. Cath- ..s, Ont., has been elected president, and Canadians are well represented in its membership. The

Association is a most valuable one in that, by the co-operation of its members, information concerning water-works affairs is brought to the public attention. Water supply systems are among the most important of the public service enterprises, and it is only through the cordial co-operation of the heads of waterworks departments that increased efficiency can be secured. It is surprising that the present membership of the Association is not greater when one considers the great benefits the Society are conferring. Its field of usefulness is a large one, for it deals with one of the prime requisites of our modern civilized life.

THE INSTALLATION OF ELECTRICAL MINING EQUIPMENT.

The use of electrical machinery in mines is steadily increasing. The many advantages of its use has tended towards this increase, but the requirements of safety as well as those of efficiency must be considered when installing electrical mining equipment. So important has this been considered by the United States Bureau of Mines that Mr. H. H. Clark, in the technical paper issued by the Bureau has taken up the subject quite extensively. The paper calls attention to the fact that, wherever the service conditions are indeterminate or variable, engineers are accustomed to use factors of safety in their designs, especially in those cases where the protection of human life is a consideration.

To quote from the paper: "The safe operation of electrical mining equipment is an engineering problem that invloves the element of human life, and that is influenced by conditions and events that cannot always be foreseen. The successful solution of the problem will, therefore, depend largely upon the factor of safety that is considered in the selection, installation, and maintenance of such equipment."

The paper proceeds to classify the electrical accidents that may occur in mines, and states the principal sources of danger incident to the use of electricity underground, and the paper shows that the requirements of ment in mines are compared to similar conditions above ground, and the paper shows that the requirements of mining work present certain difficulties in the way of maintaining electrical apparatus in perfect condition. The effect of roof-falls, dampness, dust, and acid water are mentioned, and the observation is made that the temporary character of underground work limits the economical investment in electrical equipment and its installation. The author does not regard the safeguarding of mine electrical equipment as a simple problem, and states that there is no general formula for its solution. It is suggested, however, that a logical step would be to remove contributory causes by placing lights and erecting guards at particularly dangerous points, and by selecting apparatus especially designed to offset the effect of dampness and dust. A concrete view of the problem is presented as follows: "The problem of safeguarding may be divested of some of its vagueness and put in concrete form by considering that if the electric current can be kept where it belongs—in the conductors designed to carry it—it cannot give shocks, set fires, or ignite dust or explosives. Electricity becomes actively dangerous only when it breaks away from its proper channels in stray currents, or as sparks and arcs."

Stress is laid upon the importance of first-class installation at the outset and frequent inspection of equipment after it is in place. The author considers that a competent electrician is needed to ensure the safest and most efficient operation of mine electrical equipment, and dwells upon the responsibilities and requirements of such a position.

EDITORIAL COMMENT.

We draw attention in this week's issue to the Index for the past six months.

* * * *

The destruction of cement mortars and concrete through expansion and contraction has an exceedingly important bearing for the engineer. The use of mortar and concrete, in engineering structures, is so extensive that any investigation having for its aim the determination of facts regarding the action of the materials under the conditions of use will be welcomed by all. In this issue of *The Canadian Engineer* will be found an abstract of a paper by Prof. A. H. White before the American Society for Testing Materials. Investigations conducted by Prof. White appear to show that cracks in concrete and mortar are due, not so much to the expansion and contraction from temperature change, but rather the volume change, due to alternate wetting and drying. The paper will repay careful reading.

* * * *

The Canadian Electrical Association convention always repays attendance, as the members well know. This year's meeting, which was held last week in Ottawa, was successful, both from the point of view of numbers in attendance and the discussion resulting from the papers read. The discussion on the paper by Dr. H. T. Barnes on "Ice Troubles in Connection with Power Plants" was particularly worthy of mention. The paper will be found in this issue of *The Canadian Engineer*. Dr. Barnes has spent many years on the study and investigation of the formation of ice in our northern waters, and it is surprising that the fundamental precautions he outlines in his paper are not universally followed by hydraulic power companies in Canada. There appears, however, to be an absolute disregard of all precaution in the design of many power plants now operating, and as a result every winter brings reports of shutdowns through ice troubles.

MUNICIPAL WORKS CONSTRUCTED BY CIVIC LABOR.

An editorial in a recent number of the Galt, Ont., Reporter deals with the above subject and states that the contractor, in as much as large civic works are concerned, has been unknown here for years—to be exact, not since 1905-6, when the $225,000 sewer contract was finished—and though many mistakes have been made, citizens prefer the present system, under which this municipality is to-day employing nearly 100 men in the construction of various civic works.

ENGINEERING WORK IN SOUTH AMERICA.

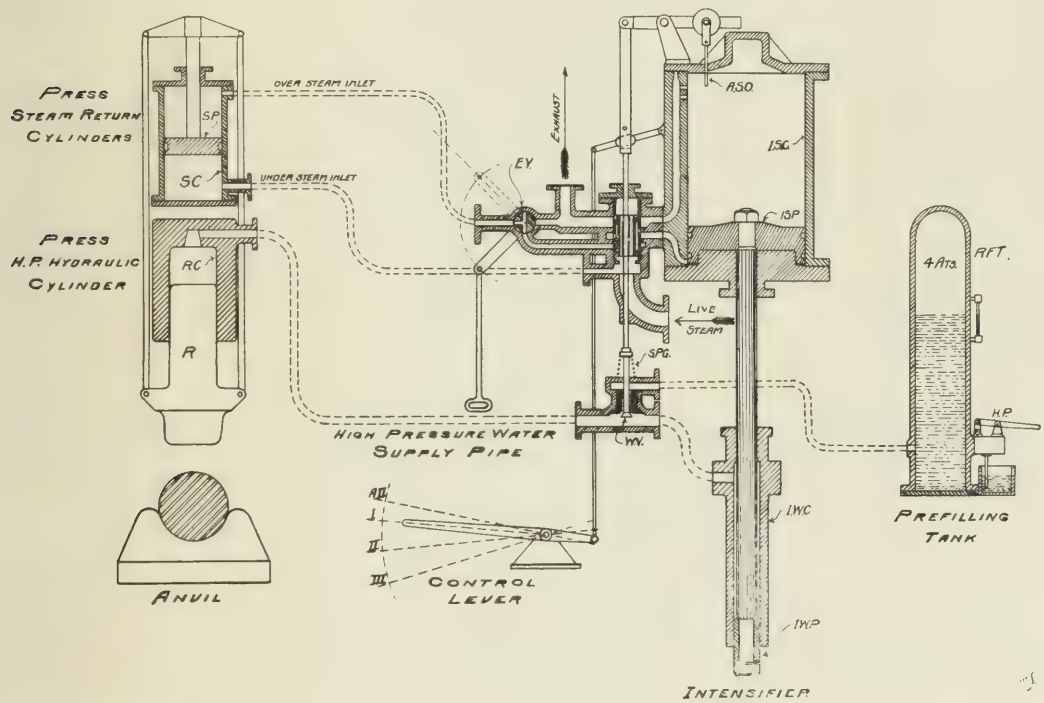
The British firm of S. Pearson and Sons, Limited, London, have received official advice from the Chilian government that the contract amounting to $13,000,000, for the construction of the new port at Valparaiso, has been awarded to them.

THE NEW STEAM-HYDRAULIC FORGING PLANT AT THE NEW GLASGOW WORKS OF THE NOVA SCOTIA STEEL AND COAL COMPANY, LIMITED.

The growth and development of its steel trade has now come to be an accepted standard for measuring a country's industrial progress. Canada's expansion in the last thirty years is strikingly shown by her steel statistics, but it is even more vividly brought home by the accomplishments of the pioneer in this line, the Nova Scotia Steel and Coal Company.

Starting as a country forge-shop with four thousand dollars' capital, this concern has expanded until its capitalization is fourteen millions, and it controls all the operations entering into the production of some six or seven hundred varieties of finished and semi-finished steel products. Particular attention, however, has always been paid to the line of work first carried on and there has never been a time when it could not claim to be the leading forge company of Canada.

By the recent installation of a complete new plant in this department, substituting steam-hydraulic presses for the hammers so long used, it has not only outstripped any Canadian company, but is in a position to challenge the product of any similar company in the world.



Diagrammatic Sketch of Steam Hydraulic Press, showing the operating cylinder and valve systems with single control lever.

Man's ingenuity has been taxed frequently to produce the massive forgings required by the engineering and mechanical advancement of the past century. Often it has seemed tnat great projects could not be carried out for lack of facilities to produce the immense steel shapes required for some particular design, but in the invention and development of the steam-hydraulic press, it would seem that these difficulties had been overcome and a principle had been discovered which would dispel all engineering difficulties of this nature.

Nasmyth's invention of the steam hammer in 1833 revolutionized the forging process of his day. During the latter part of the nineteenth century such enormous progress was made in the engineering and shipbuilding that forgings were required of a size unknown not many years previously. In turn, this resulted in a great increase in the size of forging appliances. Steam hammers were largely used at first and served their purpose well, but as the size of forgings grew, the hammer, being unable to develop a [illegible] penetration, became more and more unsatisfactory, and hydraulic-forging presses, operated by means of accumulators, were introduced. Among the first of these was one constructed at the Armstrong Works in 1850. However, they proved so slow in operation, and so expensive, that large steam hammers could still successfully compete with them. In 1860 a hammer was installed at the Krupp Works, Essen, Germany, having a 50-ton ram and a 1,000-ton anvil, while as late as 1901 a 125-ton steam-hammer was installed at the South Bethlehem Works of the Bethlehem Steel Company. Although the latter was easily the largest hammer ever constructed, it was discarded after only a few months' operation and replaced by the more efficient press.

With a hammer of this size, the force of the blow was enormous, but there were numerous difficulties in its operation. The energy developed, depending upon the weight of the falling parts, and the height through which it acted, was delivered suddenly and was exerted for but a moment. Repeated blows were therefore necessary, taking longer time than the press, and with a consequent low efficiency in steam consumption. The constant vibration made it difficult to keep a large hammer in adjustment, and wear and tear was excessive. And, lastly, the lack of control with which the blow is delivered made it a difficult operation to produce good work, and particularly to finish up heavy forging. Thus the relatively small output, and operating cost, makes hammers economically as well as technically unsuccessful in dealing with heavy forgings.

The need for a more effective and cheaper method of manufacture was met by the "steam-hydraulic" press, introduced in the late eighties, in which are united the advantages of the steam hammer, combined with those of the hydraulic-press. In this apparatus, steam cylinders lift the striking piece, or tup, which thus moves with the speed and force of a steam hammer; while constant hydraulic pressure may be supplied at any stage of the stroke by a large water-cylinder. This high pressure water is intensified in and flows from a separate apparatus called an intensifier. Thus the method of operation can be varied widely to meet different conditions. In the most modern type, in which the Scotia Company's presses are the last word, this feature enables much larger, as well as a greater range of work being performed with an efficiency impossible to any other apparatus.

The new Scotia plant consists of two presses complete with all manipulating devices, heating furnaces, etc., housed in a steel, brick, and concrete building 240 x 72-ft. Two electric cranes, of 50 and 30 tons capacity respectively, command the entire building. One press has a capacity of 600 tons, the other of 4,000 tons, at a steam pressure of 140-lb. per sq. in. (See accompanying plan of plant). The larger press has a distance of 128-in. x 64-in. between supporting columns,

single stroke, 7-in.; total stroke, 80-in.; weighs 740,000 lbs., and is adapted for forgings up to 75 tons in weight. As the presses are exactly similar, except in size, the following description applies to each.

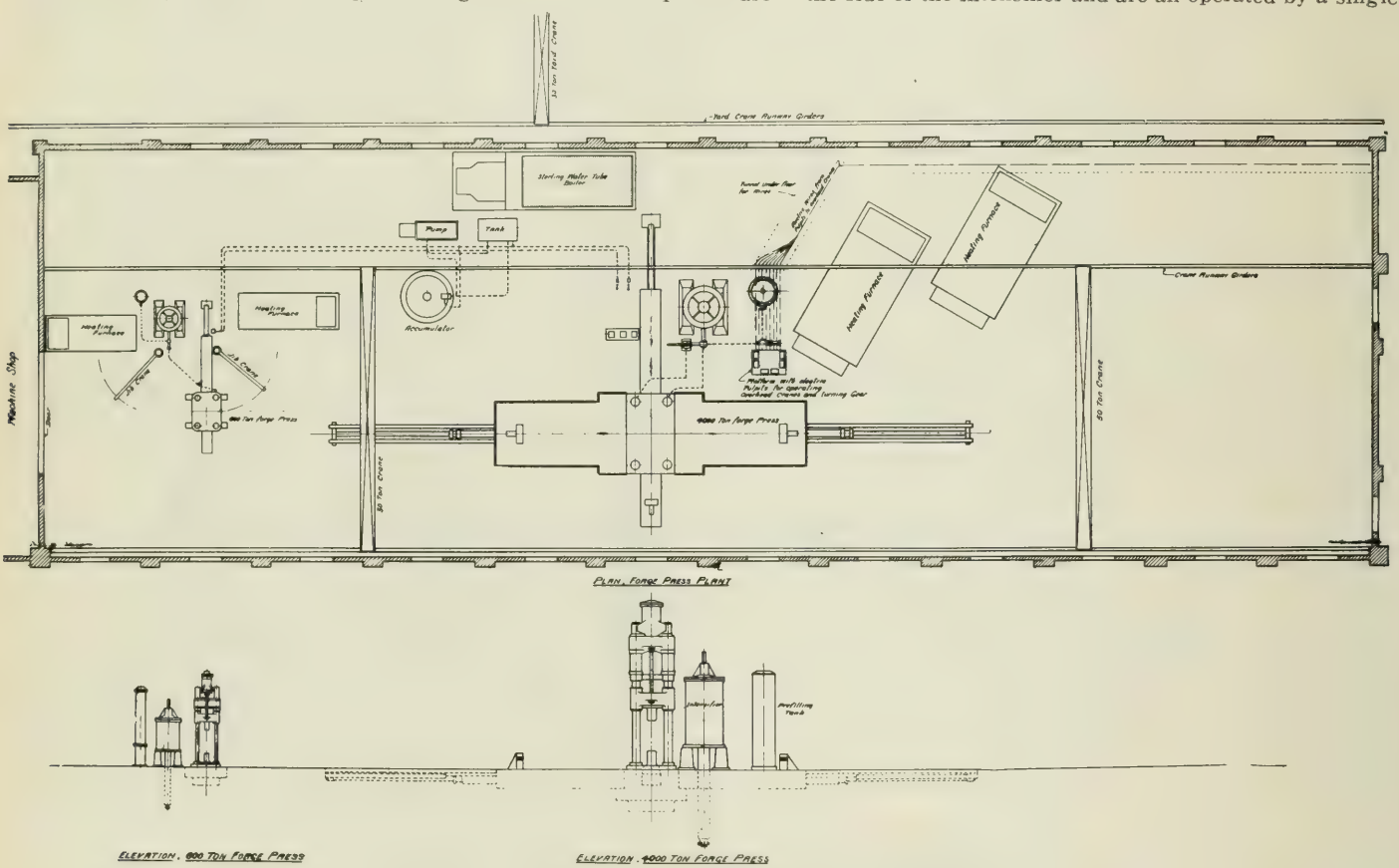
Each installation consists of the press proper, the pre-filling water tank and the patent hydraulic intensifier. The press consists of a heavy base plate, embedded in the concrete foundations, on which stands the anvil, also the four forged steel columns which support the press head. Situated near the top of the press are two return steam-cylinders, and the hydraulic or ram-cylinder which is located on the centre line of the press.

Immediately below the press-head is situated the press-traverse, the upper end of which is firmly attached to the piston rods of the three cylinders above referred to. Below the traverse is fastened the upper forging tool or tup. The traverse has four bushed guides, encircling and sliding on the supporting columns, to keep it in alignment and take up the heavy side strains when the ingot is not exactly under the tool centre.

The pre-filling water-tank is an air-chamber equipped with a pump for charging to a certain level at a pressure of 65-lbs. to the sq. in. This tank supplies water to the ram and intensifier cylinders and again stores the water which leaves the ram-cylinder when the piston rises, the flow being automatically controlled by a water valve.

The intensifier, which produces the high hydraulic pressure, consists of two cylinders, a large one, with steam actuated piston, placed immediately above a smaller one containing water. They have a common piston rod, the lower end of which, extending through and working in the water cylinder, acts as the plunger of a force pump. When the steam-cylinder piston moves upwards, the water is forced from an opening near the top of the lower or water-cylinder, at very high pressure, owing to the difference in their diameters, and enters the ram-cylinder giving a greatly increased pressure there. The intensification is 50 to 1, and gives a water-pressure of 3½ tons per square inch in the ram-cylinder.

This type of intensifier possesses many advantages over that of the ordinary type where the steam-cylinder is below, in that the design of the whole is lower, giving greater access to the working parts. The piston rod is always in tension, resulting in less wear and tear on glands which therefore are more readily kept tight. Vibration is largely eliminated by the valve arrangement which admits steam on the inside of the lower cover of the steam-piston, thus providing a steam cushion, and resulting in a noiseless drop. The valve system is automatic in controlling the press and prevents any injury to the tups or dies from below, due to momentum (for instance when cutting) for the weight of the tup is at once taken up by the under steam in the press traverse steam lifting cylinders. All the valves controlling the various operations are at the side of the intensifier and are all operated by a single lever, so adjusted that the press follows its movements in speed and stroke.



The Forge Press Plant of the Nova Scotia Steel and Coal Co., Ltd.

The press may be operated in four separate ways and under each the tup may at moment be arrested instantly and a new stroke inaugurated by a single movement of the controlling lever. The tup may be actuated (1), By the steam cylinders alone, the press then operating like an ordinary single acting steam hammer; (2), With intensifier giving high pressure only toward the end of the stroke. This is the method used in ordinary forge work; (3), With high pressure throughout the entire stroke, used in pure press work, cutting, etc.; (4), With intensifier and under steam-cylinders which results in rapidly repeated heavy blows delivered at a fixed height. This method is used for finishing work to exact size, the length of the stroke being automatically controlled.

The accompanying diagrammatic sketch of the operating cylinder and valve systems, showing the single lever control will make the mode of operating the press clear.

At all times steam pressure is acting on the under side of the press steam-piston, With controlling lever in position I., the top side stands open to exhaust. There is no movement owing to the water being confined over head of ram, the water valve, WV, being closed.

To lower ram, push the controlling lever down to II., thus balancing piston by admitting steam to both sides of it. Thus the weight of the press-traverse, assisted by the pressure of the prefilling tank (this latter having automatically opened the water valve) causes the ram to fall.

When using the intensifier, the hammer is dropped as already described, until it reaches the work, when the controlling lever is pushed down to position III. This raises the steam valve, SV, still higher, admitting steam to the large intensifier cylinder, ISC, thus forcing down ram of the press with the high pressure generated due to the difference in diameter of the steam- and water-cylinders or pistons.

By returning the lever to position II., the steam exhausts, and allows the intensifier-piston to fall; the vacuum thus formed drawing in more water from the prefilling tank. Upon pressing down the lever again, the pressure is again obtained from the intensifier.

This operation, of taking a new hold as it were, may be repeated throughout the total stroke, enabling pressing and cutting to continue at a uniform pressure for this distance. In this operation the oversteam is never open to exhaust.

Finally to obtain rapidly repeated short strokes, lower hammer to be required, then throw open the large exhaust valve. The steam is then admitted alternatively to the underside of the hammer-piston, and the intensifier-piston; this operation giving a heavy down-stroke and light up-stroke at any desired speed. To lower the range of these short strokes, open large exhaust valve, thus allowing the hammer to fall to desired height.

When making heavy forgings, whether under hammers or presses, the piece must be frequently moved and turned, especially when the finishing strokes are being given. To do this speedily and cheaply, a mechanical handling equipment has been installed, the forging being suspended and rotated by an endless chain driven by electric gear attached to the forging crane. This crane may be operated from the usual suspended cage and also from a pulpit at floor level, close to the presses. Hydraulic manipulator and mandrel gear is provided for forging long massive shafts, cylinders and turbine casings, etc. There are two hydraulic operated rests on each side of the big press for supporting long forgings. These travel twenty feet each way. Hydraulic manipulating gears are provided for adjusting the different bottom anvils. On the large press, the stroke of this appliance is about 12 ft.

The low pressure hydraulic installation operating this mechanism consists of a dead-load accumulator supplied by an electrically-driven three-throw vertical pump. The motor is 50-horse-power, and the pump supplies 50 gallons per minute against a working pressure of 720 lbs. per sq. in. in to the accumulator ram.

Rapid working, range of utility, economy and every other requirement of modern forging practice are fulfilled by this plant. The steam consumption is extraordinarily low as the cylinders do not have to be kept filled continuously. The plant is exceedingly compact and with its wide scope and splendid equipment of accessories, will be able to furnish all the Canadian requirements in forgings for years to come.

From the view-point of the consumer, the product of the steam-hydraulic forging press has many advantages. This is not only because forgings may be produced at a lower cost, for the improvement in the quality of forgings is even more important.

The product of a modern steam-hydraulic press is denser and more homogeneous than can be provided with the steam hammer, due to the effect of the blow of the latter not penetrating to the centre, in contradistinction to the uniform kneading effect of the press; while the amount of work that can be done by the latter at one time, with little variation in temperature, strongly tends to produce a better product. This simplifies the required heat-treatment by reducing the number of heating and their duration. It also prevents the liability of damage due to working at a blue heat. Thus the greater uniformity and reliability of steam-hydraulic forgings makes their use imperative wherever high-class forgings are necessary.

PROPOSED MONTREAL HARBOR IMPROVEMENTS.

According to a plan of improvement recently spoken of by the harbor commissioners of the Port of Montreal, it is proposed to expend from $1,500,000 to $2,000,000 on improvements in the west end of the harbor. The harbor of Montreal has a length of many miles, but the central or upper portion is no more than about half a mile in length. The harbor commissioners' office is close to the mouth of the lower entrance of the Lachine Canal, and from here down to Bonsecours market is situated the harbor of Montreal, as it is known to all the passenger boats and most of the large carriers of general merchandise. Here are situated the big elevators which take the grain from the upper lake vessels and tansfer it into the holds of the ocean liners. These elevators are equipped with carrying belts which discharge cargoes into vessels docked at any point along the wharves of the upper harbor. Passenger steamers all dock in this vicinity and the regular passenger companies have their offices not far distant.

Owing to all these advantages, as well as to the ease with which freight can be handled from ships docking in this vicinity to the importing and exporting houses, as well as to the railway depots, space for dockage is most desirable and there is greater demand for it than there is supply.

The harbor commissioners now propose to build a twelve hundred foot concrete pier straight out into the river from opposite the offices of the habor commission, at the foot of McGill Street. This locality is now used as a basin for vessels entering or leaving the canal, the entrance to which is nearby. As the entrance to the canal would be made difficult by the construction of this new pier, the plan includes the moving of the entrance to a point a convenient distance further west. Other improvements include the deepening of some of the old basins and the construction of other new concrete wharves, together with the lengthening of three of the principal piers now in existence, namely, King Edward, Alexandra, and Jacques Cartier piers, each of which will have 300 feet added to them. The completion of the new pier at McGill Street will provide accommodation for at least two more large ocean steamships, while the lengthening of the piers referred to and the completion of Victoria Pier, will increase the capacity of the central and most valuable proportion of the harbor by a very considerable percentage.

Meantime, work is proceeding on the completion of more elevator capacity, and on various other improvements which have been undertaken. Additional permanent sheds are being planned for the extensions which are being added to the piers and for the new piers, and it is believed that the commissioners have under consideration improvements in the way of railway facilities, to and from the ships, which will greatly facilitate the handling of freight.

THE INFLUENCE OF ICE ON WATER POWER DEVELOPMENT.*

By H. T. Barnes, D.Sc., F.R.S.†

The industrial development of our vast water powers is of great interest to everyone looking to the future. As public utilities become more and more dependent on hydraulic power, the question of continuous operation is of far-reaching importance. Chief among the causes which affect uninterrupted service is the presence of ice, which for five months of the year forms in the water. Hitherto it has generally been accepted that disturbances from ice inevitably occur, bringing about temporary "shut-downs." It has been thought necessary in every well-designed plant to instal an auxiliary steam plant to carry the load, and so far as the public is concerned, little is known outside the power house. It cannot be said that this is desirable, and in the future big developments is will be too costly. That it is not necessary it is my desire to point out in the present paper. The matter is creating not a little interest among engineers who have had personal experience of ice troubles, and the public generally are beginning to awaken to the fact that inconvenience from the stoppage of the power is not to be allowed. During the days of small developments it was a matter of little importance; but in the near future an abundance of cheap power will become available that must not be subject to caprice of Nature. Continuous service must be preserved if the confidence of the public is to be gained, and the wealth of power around us utilized to its full capacity. Canada has a great inheritance in its water powers. She is also blest with a vigorous winter, so that a study of ice conditions is of increasing importance.

Nowhere can one find a more wonderful example of the delicate poising of the forces of Nature than in one of our northern rivers. As soon as winter sets in, the water cools to the freezing point, and varies but a few hundredths of a degree for the entire period of ice production. The reason is to be found in the particular nature of the freezing process. Every liquid which produces a crystalline solid has a definite freezing and melting temperature, which we are told never varies. The process of change involves a heat transfer without temperature change. We know, however, by the second law of thermodynamics that heat cannot pass from one body to another without a temperature difference. The latent heat of water cannot pass out without a temperature gradient be it ever so small. In the case of water the molecules give up their heat readily when changing to ice, and the change proceeds rapidly when the temperature difference is only a small fraction of a degree. The microthermometer has revealed the magnitude of these temperature differences which have escaped detection in the reading of the ordinary thermometer. Thus when ice is forming rapidly, the temperature is found to be of the order of a hundredth of a degree below the freezing temperature, and the heat flows out of the molecules to keep the water from going lower. Similarly, when ice is melting rapidly, the temperature rises slightly. As a rule, ice forms, and that which is already formed, grows when the temperature is only a few thousandths of a degree lower than 32° F. Water can crystallize at a certain rate. When the heat loss is rapid, the temperature falls, thereby accelerating the ice production and preventing too rapid a growth. Similarly, ice can melt only at a certain rate, and the rapid supply of heat results in a slight rise of temperature in the water which accelerates the melting. A mixture of ice and water is at the true freezing point only when it is neither gaining nor losing heat. Rapid freezing or melting results in a temperature slightly lower or higher than this. Hence we find the balance in Nature continually swaying one way or the other, depending on the outside conditions.

It is doubtful whether the ice itself wetted on the surface ever differs from the true freezing point, since the surface of the crystal emits or parts with the latent heat, and is thus continually surrounded by a source or sink for the heat produced. The birth of an ice crystal takes place by the disturbing influence of foreign matter in the water such as fine particles of denudated material and by the direct action of cold air churning up the surface into spray which falls back frozen. The vapor from open water also furnishes the nucleus for the ice crystal, and the beautiful ice flowers noticed on a very cold day on thin ice are caused by the freezing of these particles. The steam noticed on a cold day from open water is a direct sign of the comparative warmth of the water, and must supply a vast number of small crystals which fall back into the current.

There are three distinct forms of ice met with in Nature; there are, surface ice, frazil ice and anchor—or ground—ice. Of these, frazil ice is the most troublesome to power houses, and causes probably all the "shut downs." I will briefly describe all these forms.

Surface Ice.—Wherever water is still, ice forms rapidly over the surface and closes it in. This ice starts in two ways, depending on the general weather conditions. It may spread over the surface quietly, commencing from the shore and working outward, forming a sheet that is smooth and often clear, but it forms more often from the freezing of the frazil and scum ice blown by the cold wind into the bays or inlets. In this case the ice grows backwards against the wind, being increased by the fresh accumulations. This surface layer is rough and opaque, and consists of large and small pieces with the crystal pointing in every direction. While the first method of freezing requires absolutely quiet conditions, the second will often proceed over the surface of quite a rapid current. In both cases the water must be at the freezing point; and the heat carried off by the cold air. The effect of a wind is to increase very much the heat loss, and, therefore, the second method is the one which causes the more rapid freezing. Evaporation from the surface furnishes a large part of the heat loss due to the high latent heat of vaporization. Hence a wind from the north with little moisture in it will produce more evaporation and a greater ice production than one of the same temperature from the east or south. But, as a rule, a north wind is accompanied by fair weather, and sunshine inhibits the ice production to an enormous extent. An east wind with clouds and snow often causes vast numbers of crystal nucleii in the water.

As soon as the first ice layer forms, by whichever method, the wind is shut off from the surface, and scum ice is no longer formed. The ice sheet now grows rapidly in thickness by the conduction of heat through the ice to the cold air above. The rate of growth of ice may be calculated from ordinary data of heat conduction. The velocity of the wind and the rate of evaporation of the ice surface also determines the rate of growth. Presumably the water under the ice is at 32 deg. Fahrenheit and layer after layer of ice is frozen on. The ice thus produced is of great purity, since the freezing proceeds so gradually that air and frozen matter are readily expelled. It is always possible to tell this ice from the first layers, as it is clear and hard. The crystals are all grown with the main axis at right angles to the surface. Hence when the surface becomes rotten in the spring, the ice often consists of a lot of vertical needles standing on end. A wind or current will topple these over, and they quickly melt, giving rise to the

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tradition that surface ice sinks in the spring. Surface ice grows more and more slowly as the thickness increases, until it finally becomes stationary. It then proceeds to melt and decreases in thickness until the warm sun of April rots it away.

There is a limiting thickness to the surface ice which is determined by the temperature of the water under the ice. In our rivers the water gently flowing along the under surface of the ice is seldom exactly at the freezing point. This is due to not only the natural heat of the river bottom, which is entrapped in the water flowing over it, but also to the increasing power of the sun in the late winter months. The limiting thickness of the ice is due to this, and the decrease towards spring to the rising water temperature. The average water temperature under the ice is about 1/100th of a degree as shown by the microthermometer. In cases where undercurrents are brought to the surface, we find what are called air-holes in a lake or river otherwise frozen over. This is due to the higher temperature at these places which prevents the ice from growing, and rapidly melts any surface layer formed at the outset of cold weather.

Surface ice, when it can be induced to grow, is a protection to the water, and prevents scum and frazil ice, but also holds the water temperature back long into the spring, turning back the greater part of the sun's heat. Water running under surface ice faster than half a mile per hour, will carry with it floating ice. Attention must be directed to this whenever an intake is situated in open water. Surface ice may also prove to be a menace and a continual source of trouble, as will be better understood when frazil ice is described.

Frazil Ice.—Frazil, as its name implies, is cinder-ice, so-called by the French from its resemblance to cinders or ashes. It is the fine needle ice found floating in the open water, and varies in size from minute crystals to large agglomerated masses. It is formed by surface cooling in water flowing too swiftly for surface ice to form. An estimate of the number of these crystals in a cubic foot of water shows on an average cold day in winter about a quarter of a million, but this I have found often reaches several millions. The current carries these crystals downwards and under the barrier of surface ice which extends over the quieter parts of a river, and there they settle upwards and become attached to the under side of the surface sheet. In a short time immense hanging dams are produced which impede the water course and cause a rise of the water level. During cold weather the under passages may become blocked entirely and a rapid rise of water produced above the dam. When sufficient head of water is gained, the whole ice jam is forced out and a winter "shove" produced. At some parts of the river, like the St. Lawrence, there is a continual rise and fall of water level going on all winter. This frequently interferes with the normal head of a power house and causes serious trouble.

During the period of rapid formation of frazil ice, the water is slightly below the freezing point, and, in consequence, the crystals are growing rapidly. They readily freeze and form agglomerated masses, and they attach themselves to objects immersed in the water which are likewise cooled slightly below the freezing point. The time during which supercooling takes place does not last very long, and is quickly relieved during the periods of fine sunny weather.

Anchor Ice.—Whenever a river is open in winter, the presence of ice growing on the surface of objects immersed in the water is observed. This ice forms in long needle crystals attached in the same manner as the ice flowers. As the ice thickens, the crystals become large, and finally form masses many feet thick of coarse-grained crystals. Anchor ice forms primarily from the cooling of the river by radiation. Water is an almost perfect absorber of heat, and, likewise, it is an almost perfect radiator. During the intense radiation at night in winter when the sky is clear and the air almost devoid of water vapor, the water and objects in it become supercooled. Ice forms rapidly and covers the entire river bottom. During the day the effect of the sun is to raise the water temperature slightly, and the ice soon loosens and rises to the surface.

Anchor ice plays little part in power house troubles, for during the period of frazil sticking, the anchor ice is frozen to the bottom and held in place. In fact, it appears to remove many of the frazil crystals in as much as it is growing rapidly and readily causes an adhesion of the fine needle crystals.

Power House Location.—A power house may be situated at a rapid or fall where the water normally freezes over for many miles above. As soon as the winter ice is formed, usually no trouble from ice need be feared. Until, however, the river closes in, a period of frazil production may result and consequent closing down of the plant.

Sometimes open water conditions above compel a long forebay to be constructed where the surface ice is allowed to form. If the forebay is fed from open water, frazil jams are sure to occur, and the free waterway reduced or stopped altogether. It is better to run a canal up to the position of permanent surface ice to avoid this. When jams occur, little can be done beyond blowing up the ice by dynamite and blasting out a clear channel. In this case men must be stationed to remove the frazil from the channel, as the ice is drawn in by the current. When a forebay is fed from open water, it is better to keep it from freezing and handle the ice at the power house.

Ice troubles at the power house show themselves in the freezing of the racks, gates and turbine wheels. Special heating devices must be provided to avoid the sticking and freezing of the frazil crystals. The ranks must be protected from the direct action of the cold air by a curtain wall, and may to advantage be heated. The iron bars of the rack when exposed draw the heat from the water and cause an abundant supply of anchor ice even when the water is not supercooled. By enclosing the racks, the natural heat of the water has full effect, and usually nothing is needed to keep them free of ice.

When a power house is fed from open water, at times frazil may come down in such quantities as to stop the racks mechanically. In such a case the ice can be removed mechanically. Revolving racks would be of great service under such circumstances. For the turbines and gates steam-heat may be used, as in Mr. John Murphy's appliances. It is only necessary to keep the surface of the machinery a very small fraction of a degree above the freezing point, and this can be done easily. Mr. Murphy, who has already read a paper before this association on ice troubles, has been wonderfully successful, and a visit to the Ottawa and Hull Power Company will show the practicability of his apparatus. Repeatedly the stations equipped with his units have been running when neighboring stations not so equipped have been shut down with not a wheel turning.

The tail race sometimes causes trouble when the ice jams below and causes the level to rise. This is the most difficult to deal with. It involves dealing with the channel below, which is often too costly for a small development. By maintaining an open channel below, trouble of this kind can be avoided. In general we can give some rules for avoiding ice troubles:—

1. Have covered racks and steam-heat provided for the trouble which always comes to a power house before the permanent ice forms.

2. Instal a few meteorological instruments to watch the weather in order to be prepared for the first cold snap.

3. Where the forebay is fed from a lake or canal, induce freezing as soon as possible: otherwise maintain an open channel down to the power house. Provide a special way for floating frazil.

4. Watch the temperature of the winter at the outset of cold weather, and when 32° F. is approached, have the steam-heating plant in readiness.

CONVENTION OF AMERICAN WATERWORKS ASSOCIATION.

The members of the above association held their thirty-second annual meeting in Louisville, Ky., on June 3-8 last. Mr. Dow R. Gwinn, of Terre Haute, Ind., presided in the absence of the president, Mr. Alexander Milne, of St. Catharines, Ont.

After the reports of the various committees had been presented several papers dealing with matters of interest to the members were read and discussed.

Three papers dealing with efficient management of large works were presented by Mr. Harrington Emerson, of New York, Mr. E. C. Church, of New York, and Mr. I. M. de Varona, also of New York.

Prof. Albert F. Ganz presented an illustrated paper on Electrolysis from Stray Electric Currents.

Considerable discussion followed the reading of papers on "Water Waste," by Mr. Edward S. Cole, of New York, and Mr. F. H. Shaw, of Lancaster Pa. Mr. Reimer mentioned in the course of the discussion that East Orange, N.J., had reduced the per capita consumption from 93 to 80 gallons by combined inspection and metering 25 per cent. of the services.

Dr. D. D. Jackson's paper on "Results of Chlorination at Cleveland, Ohio," was illustrated with lantern slides. He outlined the seasonal and geographical typhoid distribution in Cleveland as well as at a number of other cities. Valuable tables on typhoid rates for the past three years in 16 cities having populations of 100,000 and over with a filtered water supply showed up the large amount of typhoid that is due to general sanitary conditions. Relative percentages of typhoid rates in Cleveland he classified as follows: 10 per cent. of the water supply, 10 per cent. to out of town cases, 10 per cent. to raw foods, 30 per cent. to general sanitary conditions and 45 per cent. to contact cases.

An open discussion followed the reading of this paper which ended by resolutions being passed urging upon boards of health the importance of ascertaining and recording the distribution of typhoid fever by causes and modes of infection to the end that a division of responsibility may be made between water supply, contact cases, general sanitary conditions, milk and other food supplies liable to contamination and typhoid carriers. It was further resolved that boards of health be urged to do their full duty in the elimination of all causes of the spread of typhoid fever, including the use of polluted private wells, or other polluted water, when a pure public water supply is available.

The election of officers for the coming year resulted as follows: Mr. Dow R. Gwinn, Terre Haute, Ind., president; Mr. Robert J. Thomas, Lowell, Mass., first vice-president; Mr. John A. Affleck, Harrisburg, Pa., second vice-president; Mr. George G. Earl, New Orleans, third vice-president; Mr. Theodore A. Leisen, Louisville, Ky., fourth vice-president; Mr. Charles R. Henderson, Davenport, Ia., fifth vice-president; Mr. J. M. Diven, Troy, N.Y., secretary and treasurer; Mr. H. E. Keeler, of Chicago, Mr. Leonard Metcalf, of Boston, and Mr. Leslie C. Smith, of Cleveland, finance committee.

The convention next year will be held in Minneapolis.

TESTS OF STEAM TURBINES.

The results of the following tests on the Zoelly steam turbine are of considerable interest. The capacity of the turbines ranged from 1,250 k.w. to 10,000 k.w. The resulting steam consumptions are of interest on account of the low figures obtained, and from the fact that the increased consumption at partial loads is kept within very narrow limits when it is remembered that the efficiency of the generator is decreased considerably when running at loads below normal. The figures from the official tests have been furnished us by Mr. T. Heyerdahl, chief engineer of the Escher-Wyss Company in Canada:—

Two 1,250 k.w. Zoelly turbines, 3,000 r.p.m., delivered to the municipal power station at Drammen, Norway; in commercial operation since January, 1912. The official test was carried out February 19th and 21st. 1912:—

Load.	Full.	Three-quarters.	Half.
Power in k.w., inclusive of excitation, but exclusive of power required for the condenser	1,275	981	656
Over-pressure at stop-valve of turbine in lbs. sq. in.	183.0	174.5	174.0
Temperature at stop-valve, deg. Fahrenheit	588	494	472
Vacuum at the exhaust branch in inches (referring to 30-inch mercuri)	29.06	29.22	29.42
Steam consumption in lbs. per k.w. and hour	12.60	13.80	14.80

One 5,000 k.w. Zoelly turbine, 1,500 r.p.m., delivered and installed at the power-house of Escaut, near Antwerp. The official test was carried out January 22nd and 23rd, 1912:—

Load.	Full.	Three-quarters.	Half.	Quarter.
Power in k.w., inclusive of excitation, but exclusive of power required for the condenser	5,418	4,305	3,160	1,184
Over-pressure at stop-valve of turbine in lbs. sq. in.	167.0	168.0	173.5	169.5
Temperature at stop-valve, deg Fahrenheit.	588	556	559	520
Vacuum at the exhaust branch in inches (referring to 30-inch mercuri)	28.90	29.10	29.26	29.55
Steam consumption in lbs. per k.w. and hour	11.92	12.32	12.65	14.70

One 10,000 k.w. Zoelly turbine, 1,250 r.p.m., delivered for La Société le Triphase à Asnière. Officially tested February 12th, 1912:—

Load.	Full.	One-third.
Power in k.w., inclusive of excitation, but exclusive of power required for the condenser	10,006	3,678
Over-pressure at stop-valve of turbine in lbs. sq. in.	154.0	162.5
Temperature at stop-valve, deg. Fahrenheit	566	567
Vacuum at the exhaust branch in inches (referring to 30-inch mercuri)	28.72	29.19
Steam consumption in lbs. per k.w. and hour	12.00	14.52

STANDARD HOSE COUPLINGS AND HYDRANT FITTINGS.*

By F. M. Griswold.†

The first concerted attempt to secure the adoption of a standard hose coupling dates from the organization meeting of the "National Convention of Fire Engineers," in Baltimore in October, 1873, when with the lesson of the great Chicago fire of 1871, added to that of the conflagration in Boston, November, 1872, before them, this assemblage of fire chiefs adopted the following resolution: "Whereas, experience has shown that the fire departments of the country should be provided with a universal or standard coupling for hose and fire hydrants, so that when a city or town calls for aid, in case of large fires or conflagrations, from another city or town, that each department can act in unison with the other; therefore, be it resolved that a committee be appointed by this convention to take under consideration, and report back to this Convention the practicability of adopting a standard coupling of some kind to be used by all fire departments throughout the United States."

The standard thus established was of 2½-in. inside diameter, 3 1/16-in. outside diameter over thread of male end, with 7½ threads to the inch. Some chiefs changed their couplings to conform to this and have since maintained that standard in operation. But standardization failed of immediate accomplishment because no concerted and continued action was undertaken to keep the proposition alive.

The firemen's convention of 1875 adopted as its standard a coupling showing 2⅝-in. inside diameter, by 3⅛-in. outside diameter "exclusive of the thread" and of 3⅜-in. outside diameter inclusive of the thread, the latter to be 8 to the inch. In 1878 a special committee reported that the 1875 specifications were found to be "impracticable in use."

In 1879 the firemen again took up the subject and this time submitted as their standard a coupling showing 2½-in. inside and 37/32-in. outside diameter with six V-shaped threads to the inch, which was duly adopted. The matter lay dormant until 1883, when the 1879 specification was endorsed and resolutions passed to secure co-operation through state legislation.

In 1890 the Firemen's convention appointed a committee to report a standard for adoption in 1891. Mr. C. A. Landy, chairman of the committee presented a report covering coupling dimensions in 1339 towns where 2½-in. fire hose was in service, showing outside dimensions over male ends ranging from 3 to 3⅜-in. and including 7, 7½ and 8 threads to the inch. Having demonstrated by the use of a model coupling of 3 1/16-in. outside diameter, with 7½ threads to the inch, that about 70 per cent. of the couplings listed might serviceably be converted to use with a coupling of these dimensions through the simple process of decreasing the diameter of the male thread, or of increasing that of the female swivel, he urged the adoption of a standard conforming to these dimensions as an intermediary which would permit standardization at the least expense.

The feasibility of adapting these non-conforming couplings to practically serve with the proposed standard carried conviction to the members of the Convention and a standard for 2½-in. hose was adopted under specifications showing 3 1/16-in. outside diameter over male end, with 7½ threads to the inch, but in nominating the number of threads for the larger sizes of couplings, the committee then having the matter in charge, increased them in ratio proportional to the expansion in diameters, thus presenting a mechanical anomaly not to be tolerated in practice.

For thirteen years after the adoption of a standard in 1891, which action was simply an endorsement of the specifications of 1873, the hose coupling proposition appears to have reposed in undisturbed quiet.

Confronted with this record of 31 years of failure, the National Fire Protection Association selected the writer as its delegate to the convention of the International Association of Fire Engineers at Chattanooga, in 1904, instructing him to propose joint action to devise an acceptable coupling. This proffer of co-operation was accepted and a committee appointed to take charge of the work.

This committee suggested as a standard coupling for 2½-in. hose one showing a diameter of 3 1/16-in. over male end thread, with 7½ threads to the inch, by the use of which it was practically demonstrated that couplings ranging in outside diameter from 3 1/32 to 3 5/64-in., with either 7, 7½ or 8 threads to the inch, could be so modified as to serviceably couple-up with this suggested standard, and thus render over 70 per cent. of the majority couplings known to be in use conformable to the proposed standard at small expense.

The committee took the matter up with the Insurance Committee of the American Waterworks' Association in April, 1905, at which there was also present a number of the associate members of the Association. The specifications were critically considered and accepted without change, and were adopted by the Association in 1905. The writer also presented the proposition to the International Association of Fire Engineers at Duluth, 1905, when the convention voted almost unanimously in the approval of the standard specifications. Following this action at Duluth the committee secured other approvals of the standard from important organizations.

When this proposition was first presented to the American Waterworks' Association the committee held data relating to couplings' dimensions in only about 1,600 separate localities in this country. Since that time it has created a card index record covering 3,133 towns in the United States and Canada. Analysis of the data shown in this record, based upon actual results accomplished in the conversion of non-standard couplings to safely interchange with the established standard, demonstrates that approximately 80 per cent. of the couplings listed are either of standard dimensions or may readily be so modified as to conform to them.

The record shows 73 cities in which the standard has been put into service, seven of these installations including the complete substitution of standard couplings and hydrant nipples in place of previously prevailing non-standard devices.

In St. Louis, Mo., over 11,000 hydrant outlets and the couplings on many thousands of feet of fire-hose were changed from 6-thread to the standard by city employees, at an average net cost of $1 per hose coupling, and $2.82 per hydrant outlet, the latter being principally of 4½-in. steamer suction type, each of which was laboriously chipped-out by use of a cold chisel.

During the winter of 1910-11, Sprinfield, Mass., discarded the Universal clutch coupling and substituted for it the standard, changing over 1,350 hydrants, some of which had four outlets, at the rate of from 50 to 100 outlet replacements per day, at an average net cost of $1 per outlet, giving credit for the old metal, and excluding cost of labor performed by the regular force of water-works employees. Couplings on 2,000 feet of hose were changed by department employees at a like net cost of $1 each.

This work was carried out in the winter. Where hydrant nipples were leaded-in, the use of a 6-lb. sledge proved an efficient means for their removal, while in the case of screwed-in nipples, an expanding wrench entered from the out-board end of the nipples engaged the operating lugs and permitted the easy removal of the device, while the 4½-in. leaded-in suction nipples were melted out by a plumber's blow torch, at the rate of 5 minutes per operation.

*Abstract of paper presented at 32nd annual convention, Louisville, June 3rd to 8th, 1912.

†General Inspector, House Insurance Co., New York.

NEW TYPE OF STEEL FORMS.

The increased use if concrete for pipe and conduit manufacture has made time and energy spent in form improvement profitable, and from this fact is due the many and satisfactory methods of conduit manufacture now in use.

Many of these machines manufacture the pipe in sections, which are so formed at the ends as to allow them to be bonded together. The "Blayney" system recently patented, allows the conduit to be constructed in one piece, and presents some features worthy of comment. A description of the system follows:

Wooden forms are bulky and clumsy to handle; they shrink and swell; are difficult to clean; costly to repair each time they are used and are useless after being used a few times. Wooden forms are expensive because they require skilled labor to handle and without special care they will leave a rough surface which is objectionable in many concrete pipes.

Extensive use has demonstrated the desirability of using steel forms. Their first cost is more than that of wood, but the total cost of steel forms is much less than the total cost

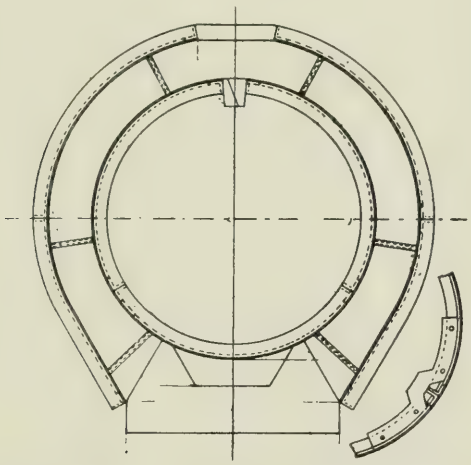


Fig. 1.—End Sectional View of "Blayney System" Collapsible, Telescoping Steel Forms and Centering.

of wood forms. One set of steel forms is sufficient to complete the longest pipe in existence, or contemplated, and still be good, providing only reasonable care is exercised. The steel forms will leave a smooth surface, so that little pointing of the concrete is necessary.

The advantages of steel forms and centering are many. They are callapsible and telescoping, so that no forms are idle. Therefore less forms will do more work, because they are all in use at all times during the progress of the work. The forms will either be ready for pouring the concrete or supporting green concrete. As soon as the concrete is sufficiently set, the forms can be taken down, collapsed, and passed through the forms ahead and re-assembled ready for concreting without interfering with the concreting of the section that is already being poured.

A pipe built with this system is a continuous concrete monolith, built, or poured, in sections of whatever length constitutes a day's work. This may be twenty feet or it may be one hundred feet or more. The total circumferential section should be built in one pouring and in that way avoid all horizontal seams or joints.

The dove-tailed bulkhead is removed, and each succeeding day's concreting is poured against the green dove-tailed end of the previous day's work. This method secures a bond and an even bed is secured for the pipe.

The forms are made of sheet steel, bent to the required shape, with stiffeners or ribs of angle iron riveted to the plate. They are made in segments bent to conform to the contour of the desired pipe. For a round pipe the segments are symmetrical and therefore interchangeable. This adds to the speed with which the forms can be erected. Each

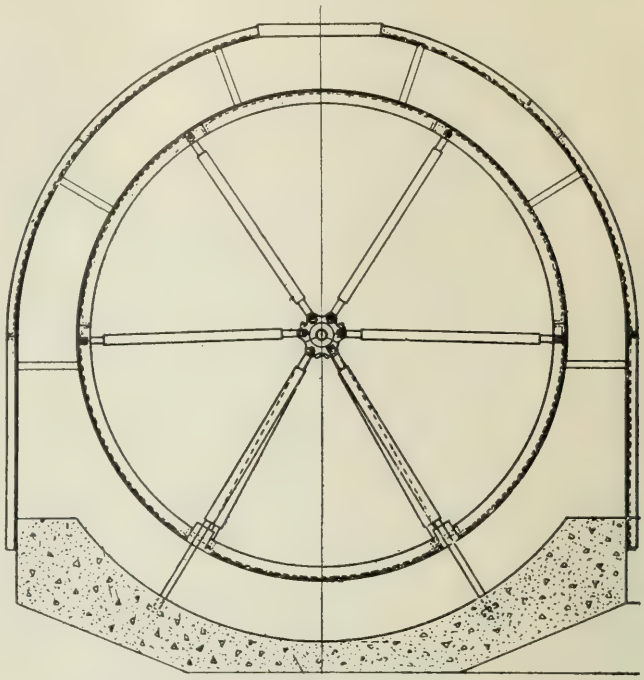


Fig. 2.—The System Used for Building Large Concrete Pipes.

segmental section of inside forms is small enough to allow it to pass through the forms ahead. Each segment is bolted to its adjoining ones, making, when assembled, a rigid form.

The outside forms may be built up as the concrete rises, thus allowing working space for tamping the concrete.

For pipes larger than seven feet it is necessary to have inner bracing. Figure 2 shows this bracing. It consists of a longitudinal central shaft on which is a cast iron collar which is shown in Figure 3. This shaft is supported by two legs running from the footing in bottom trench, or saddle, as the case may be, to the cast iron collar on the central shaft. By means of left and right hand male and female threads a turnbuckle effect is produced on these legs and they may be shortened or lengthened at will. This forms a simple and efficient method of holding the central shaft and consequently the whole form to line and grade.

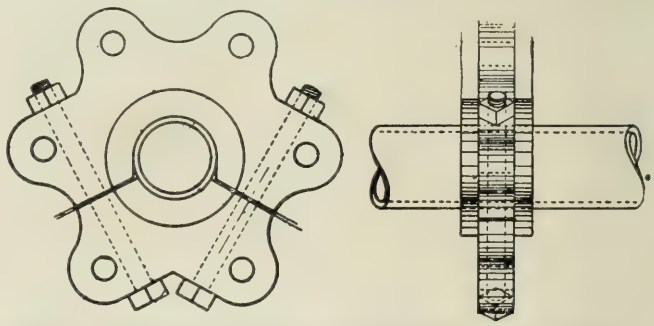


Fig. 3.—Cast Iron Collar on Central Horizontal Shaft.

From this central shaft run arms also having this turnbuckle attachment to regulate and hold the segments to their proper positions.

Like the smaller pipe forms each segment of the inside forms is interchangeable and will pass under the central shaft and between the supporting legs which holds the shaft. This will enable workmen to be placing new forms daily without interfering with the concreting of the forms

already erected. The outside forms are held in position by being accurately spaced from the inside forms by pipe separators which may afterwards be grouted.

The system is not restricted to the building of round concrete pipes as these forms are designed for and will readily accommodate themselves to the building of any pipe from round to square. The forms will take care of a curve or bend in any direction.

The system adapts itself to almost any style of reinforcing required to make the pipe sufficiently strong for its particular use. The hollow pipe separators afford an admirable chance to wire the steel to them, thus holding the reinforcing securely in place.

These forms are manufactured by the Standard Steel Form Company, Niagara Falls, Ont. The system is known as the Blayney System. The above company manufacture these forms to order. They are for sale, or lease to municipal and other corporations contractors, owners, or others who are interested in or responsible for the construction of all kinds of plain or reinforced concrete pipe, including concrete culverts, canal walls, conduits, trunk sewers, sanitary and storm sewers, twenty-four inches in diameter and over, pressure pipes of concrete for all purposes, water mains, concrete tunnels through soil, rock or water, and subways for electric, steam or other railways.

DOMINION IRON AND STEEL COMPANY, LIMITED, SYDNEY, N.S.

While the following is not intended as a complete description of the illustration which is shown in connection with this article, some of the major points in connection with same may prove of interest to our readers.

When the Dominion Iron and Steel Co. decided to extend the iron producing portion of its plant it was decided to parallel the present blast furnaces, known as Nos. 1, 2, 3 and 4, with another complement of four furnaces some 400 feet to the westward of the furnaces now operating. As all the plant units are numbered from the north to the south, it will explain how the fifth furnace of the installation was called No. 8, as the construction began from the southern end of the new plant addition.

The old plant was designed and constructed under the direction of Mr. Julian Kennedy, Pittsburgh, during ten years of operation, and has been more or less altered. With this information and precedent at hand the Dominion Iron and Steel Co. contracted with the Canada Foundry Company for the erection of the No. 8 furnace, and at a later date for No. 7 furnace, which is the opposite end of No. 8 and of equal capacity.

The illustration shows the general view of the stack, stoves, stove shelter, furnace proper and cast house from the northwest side of the plant, including also portion of the skipway where it joins the bin system. This No. 8 furnace is the second furnace to be constructed in Canada by the Canada Foundry Co., Limited, they having completed a contract for the construction of the furnace for the Atikoken Iron and Steel Company, at Port Arthur, some four years ago.

The Canada Foundry Company has recently closed contracts for a portion of the work in connection with the new Canadian Furnace Company, Limited, at Port Colborne, Ont. These facts clearly establish that this class of construction can readily be obtained in Canada.

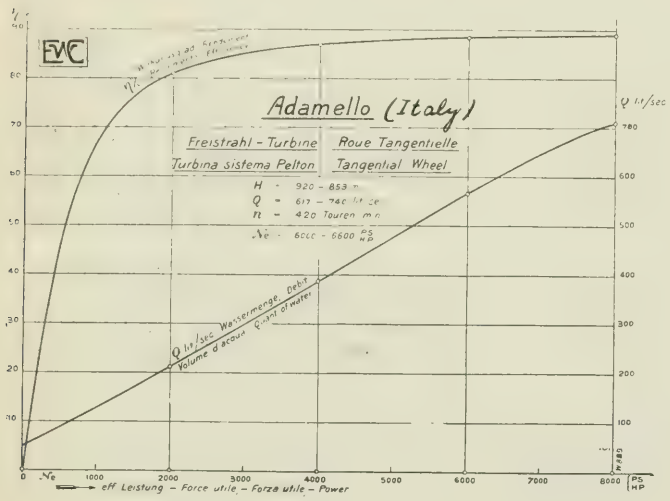
We believe that those interested in this class of engineering work who will look into the matter carefully will find that Canada has ample facilities and skill to execute all work in connection with our metallurgical developments to the entire satisfaction of all concerned.

We hope to supplement this short article from time to time with other various details of interest in this connection and at an early date furnish complete description of the above extensions referred to at the Dominion Iron and Steel Co., Sydney, N.S.

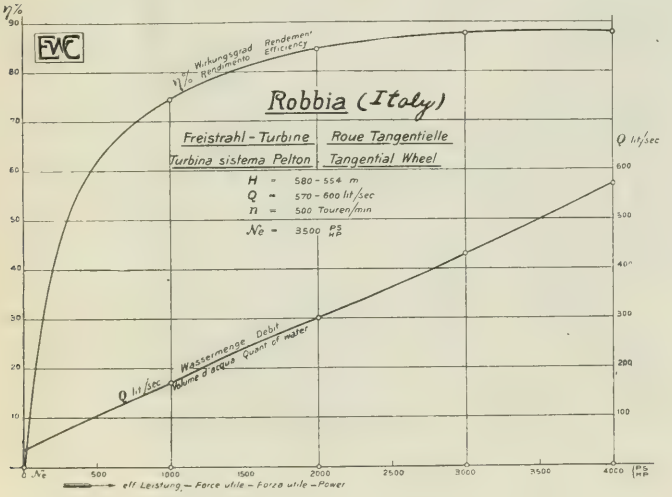
EFFICIENCY TESTS OF IMPULSE WATER-WHEELS.

The accompanying curves show the results obtained in recent tests on impulse wheels designed and installed by Escher Wyss & Company, of Zurich, Switzerland, whose Canadian head office at the Canadian Express Building, Montreal, is under the supervision of Mr. T. Heyerdahl, chief engineer. The results of the official tests as shown in the curves are exceedingly interesting on account of the efficiencies obtained.

The Adamello plant is situated on the border between Switzerland and Italy. The curve relates to an impulse turbine installation working under an effective head of 3,000


Adamello (Italy)
Freistrahl-Turbine
Turbina sistema Pelton
Roue Tangentielle
Tangential Wheel
H - 920 - 853 m
Q - 617 - 740 lit/sec
n - 420 Touren/min
Ne - 6000 - 6600 PS HP
Q lit/sec Wassermenge Debit Volume d'eaque Quant of water
eff Leistung - Force utile - Forza utile - Power

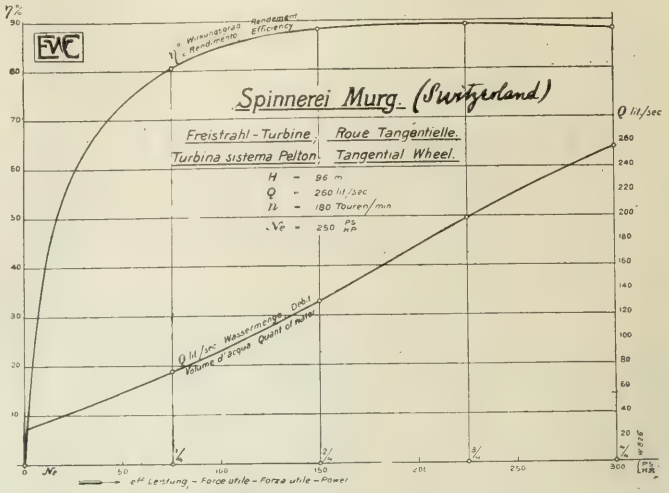
feet, each unit being designed for a maximum power of 6,600 B.H.P., when running at a speed of 420 revolutions per minute. These turbines are all of the Escher Wyss Company's special design and patent, fitted with deflecting nozzle which eliminates the employment of any relief valve, at the same time keeping the rise of pressure in the penstock remarkably low. As a matter of fact, when tests were made and the full load was thrown off, the pressure at the end of the penstock


Robbia (Italy)
Freistrahl-Turbine
Turbina sistema Pelton
Roue Tangentielle
Tangential Wheel
H - 580 - 554 m
Q - 570 - 600 lit/sec
n - 500 Touren/min
Ne - 3500 PS HP
Q lit/sec Wassermenge Debit Volume d'eaque Quant of water
eff Leistung - Force utile - Forza utile - Power

only rose to a very few per cent. above normal. The above efficiency curve which exceeds the guaranteed figures by about 8 per cent. is remarkable by the fact that it remains above 80 per cent. from over-load to one-quarter load. A general description of this plant was given in The Canadian Engineer of August 31st, 1911, where full details of the installation were given.

The Robbia plant is situated on the border of Switzerland and Italy.

This curve relates to the same type of turbine as above described, the effective head being 1,900 feet, and each unit


Spinnerei Murg (Switzerland)
Freistrahl-Turbine
Turbina sistema Pelton
Roue Tangentielle
Tangential Wheel
H - 96 m
Q - 260 lit/sec
n - 180 Touren/min
Ne - 250 PS HP
Q lit/sec Wassermenge Debit Volume d'eaque Quant of water
eff Leistung - Force utile - Forza utile - Power

having a capacity of 3,500 B.H.P. when running at a speed of 500 revolutions per minute. This curve is also remarkable on account of the efficiency remaining above 80 per cent. from full load to almost one-quarter load.

ECONOMY TESTS OF STEAM TURBINES.

The table herewith is part of a paper on the "Present State of Development of Large Steam Turbines," read at the spring meeting of the American Society of Mechanical Engineers by Prof. A. G. Christie, of the University of Wisconsin. With regard to this phase of the subject he says:—

The efficiency of a steam turbine may be expressed in terms of pounds of steam per kilowatt-hour, as an efficiency ratio or as the B.t.u. required per kilowatt-hour.

The steam consumption is dependent on the initial steam pressure, its temperature or quality, and the condenser pressure. These factors vary in almost every test and the effect of a variation in each is not the same for all classes of turbines. Hence, different turbines cannot usually be compared satisfactorily on the basis of their steam consumption alone.

If the steam could expand freely to exhaust pressure in a turbine without radiation, friction, eddy or windage losses, its expansion would be adiabatic and on the Rankine cycle. The "efficiency ratio" expresses the proportion of the heat actually turned into work to that available from such an adiabatic expansion; in other words, it expresses the efficiency of the actual turbine as compared to the ideal turbine, and is independent of the type of turbine.

The B.t.u. per kilowatt-hour is figured above the heat of the liquid at exhaust pressure. This is not a satisfactory standard by which to compare results, for it is largely dependent on conditions beyond the control of the turbine builder. For instance, if the plant does not contain superheaters, the B.t.u. per kilowatt-hour will be high. The same will be true of a plant which has a warm cooling-water supply for condensers and consequently carries low vacuum. Yet the turbines may be designed to give a high efficiency ratio under these conditions. In fact, they may be able to utilize the heat available more efficiently than the turbines in another plant with both high superheat and high vacuum.

This can be seen in the accompanying tabulation of recent turbine results. The Brown-Boveri turbine at the Dunstan power plant uses 14,980 B.t.u. per kilowatt-hour with an efficiency ratio of 68.8 per cent. Yet the Westinghouse City Electric, with a lower steam pressure, superheat and vacuum,

has an efficiency ratio of 68.9 per cent., though using 16,925 B.t.u. per kilowatt-hour. The Erste Brünner Vienna turbine requires 16,460 B.t.u. per kilowatt-hour with 71.8 per cent. efficiency ratio. It is therefore apparent that the efficiency ratio alone will express in the best manner the degree to which the designer has approached ideal results in his turbine.

The test results in the table were grouped in order to analyze the relative merits of the different types of turbines on the basis of efficiency ratios. The Curtis-Parsons machines built by Erste Brünner hold first place in the list, but are followed closely by others of the same type built by Brown-Boveri and Westinghouse Machine Co. The Parsons turbines built by Allis-Chalmers and Brown-Boveri also show high efficiencies. The second class in the order of efficiency includes turbines of the Curtis-Rateau and Curtis-Zoelly types, among which the turbines of the A. E. G. and British Westinghouse Co. show remarkably good results. The next group includes simple Zoelly and Rateau turbines. The last group comprises straight Curtis types.

The parsons low-pressure sections evidently utilize the heat in the steam only slightly more efficiently than do the impulse turbines. The great surface areas of all disk-type turbines which must be whirled in steam, produce losses which are apparently somewhat larger than the combined whirling losses and leakage in the Parsons drum turbines. Both the Zoelly and Curtis-Rateau types appear to use the steam more effectively in the low-pressure sections than the Curtis alone. Many European engineers hold the opinion that where high economy is to be obtained, the impulse turbine of the Rateau or Zoelly type is superior to the Curtis, though its manufacturing costs are higher. The Curtis-Rateau construction has all the commendable features of impulse turbines and has proved very economical.

The results in the table are from the best reliable tests that have been made on each type. Objections may be raised that these results do not represent actual operating condition as under varying loads, nor the average economy of any type of turbine. For instance, the Curtis turbine usually gives a very flat water-rate curve, while the Parsons type is more convex.

It is interesting to note that the best results have been obtained within the past two years and that these show a considerable increase in efficiency over the earlier turbines.

ECONOMY TESTS OF HIGH PRESSURE STEAM TURBINES
Efficiency Ratios Based on E.H.P. Marks & Davis Steam Tables Used

Maker of Turbine	Type	Date of Test	Load-Kw.	R.p.m.	Steam Pressure, Lb. Absolute	Temperature at Throttle, Deg. F.	Vacuum Referred to 29.92" Bar.	Condenser Pressure, Lb. Absolute	Lb. of Steam per Kw.-hr.	B.t.u. per Kw.-hr.	Heat Utilized per Lb. of Steam	Heat Available per Lb. of Steam	Efficiency Ratio	Reference
Erste Brünner M. F. G.	Curtis-Parsons	1910	2,128	1500	156.2	482	27.89	0.995	13.82	16,460	247.0	343.8	71.8	*Periodische Mitteilungen*
Erste Brünner M. F. G.	Curtis-Parsons	..	6,000	960	184.9	573	28.18	0.854	12.56	15,570	271.5	380.7	71.3	*Zeit. D.V.D. Ing.*, 12/10/'10
Erste Brünner M. F. G.	Curtis-Parsons	1910	7,442	960	192.0	584	28.18	0.853	12.625	15,705	270.2	384.4	70.3	*Periodische Mitteilungen*
Westinghouse Machine Co.	Curtis-Parsons	1910	9,173	1800	181.7	433	27.81	1.032	14.57	16,925	234.1	340.2	68.9	*Trans. A.S.M.E., vol.* 32
Brown-Boveri & Cie.	Curtis-Parsons	..	3,053	1360	150.2	505	29.00	0.456	13.01	15,990	262.2	385.5	68.0	*Dinglers P.J.*, 6/17/'11
Erste Brünner M. F. G.	Curtis-Parsons	1910	1,416	1260	128.2	482	27.60	1.137	15.18	18,060	224.6	326.5	68.8	*Periodische Mitteilungen*
Brown-Boveri & Cie.	Curtis-Parsons	1911	1,750	1500	176.4	586	27.08	1.392	14.23	17,500	239.5	354.8	67.5	*Zeit. F.D.G. Turb.*, 5/30/'11
Brown-Boveri & Cie.	Curtis-Parsons	1910	3,764	1500	161.2	561	28.77	0.562	13.04	16,290	261.5	391.4	66.8	*Zeit. F.D.G. Turb.*, 5/30/'11
Westinghouse Machine Co.	Curtis-Parsons	..	9,830	750	192.2	475	27.22	1.322	15.15	17,790	225.2	336.0	67.0	*Trans. A.S.M.E., vol.* 32
Brown-Boveri & Cie.	Curtis-Parsons	1911	1,495	3000	200.6	563	26.41	1.720	14.78	17,880	230.7	345.5	66.8	*Data from Manufacturer*
Brown-Boveri & Cie.	Curtis-Parsons	1911	1,271	3000	172.1	568	27.31	1.278	14.61	17,880	233.5	354.3	65.9	*Data from Manufacturer*
Westinghouse Machine Co.	Curtis-Parsons	..	11,466	750	191.7	484	28.07	0.910	14.45	17,210	236.0	360.5	65.5	*Trans. A.S.M.E., vol.* 32
Erste Brünner M. F. G.	Curtis-Parsons	..	1,250	3000	184.9	573	27.89	0.996	14.32	17,680	238.2	373.1	63.9	*Zeit. D.V.D. Ing.*, 12/10/'10
Brown-Boveri & Cie.	Curtis-Parsons	1910	3,320	1500	180.9	525	29.02	0.440	13.50	16,680	252.7	401.3	63.0	*Zeit. F.D.G. Turb.*, 5/30/'11
Brown-Boveri & Cie.	Curtis-Parsons	..	5,128	1000	171.2	565	28.52	0.726	14.35	17,830	237.7	382.9	62.1	*Stodola, 4th ed., p.* 449
Breitfield, Danek & Co.	Impulse Parsons	1909	3,585	896	160.7	457	28.32	0.782	16.08	19,070	212.0	352.4	60.2	*Zeit. D.V.D. Ing.*, 12/10/'10
Brown-Boveri & Cie.	Parsons	1910	6,257	1210	203.7	559	29.02	0.440	11.95	14,980	285.5	415.0	68.8	*Official Test Report*
Allis-Chalmers	Parsons	1908	4,300	1800	186.4	484	27.96	0.960	14.02	16,690	243.4	355.7	68.4	*Sibley Jour. of Eng.*, 1/'11
Brown Boveri & Cie.	Parsons	1903	3,500	1360	156.4	499	28.84	0.532	13.71	16,720	248.5	378.6	65.6	*Zeit. D.V.D. Ing.*, 12/10/'10
Brown-Boveri & Cie.	Parsons	..	3,000	1360	165.0	625	27.02	1.420	14.75	18,433	231.3	359.5	64.3	*Die Turbine*, 6/20/'11
C. A. Parsons & Co.	Parsons	..	5,164	1200	214.3	509	28.95	0.473	13.18	16,140	258.7	402.3	64.3	*Stodola, 4th ed., p.* 439
Allis-Chalmers	Parsons	1911	3,850	1800	164.7	491	27.91	0.983	15.40	18,410	221.3	348.3	63.5	*Power*, 1/2/'12
A. E. G.	Curtis-Rataeu	1911	6,518	1220	198.7	601	29.28	0.352	11.43	14,640	298.4	434.2	68.7	*Official Test Report*
A. E. G.	Curtis-Rateau	1911	6,565	1220	200.2	597	29.18	0.406	11.64	14,848	293.0	427.7	68.5	*Official Test Report*
British Westinghouse	Curtis-Rateau	1911	5,066	1500	190.2	552	28.68	0.649	13.00	16,100	262.4	391.5	67.0	*Electrical Review*, 6/23/'11
M. A. N.	Curtis-Zoelly	..	3,584	1500	178.3	569	27.54	1.166	13.99	17,190	243.7	361.3	67.5	*Data from Manufacturer*
Bergmann	Curtis-Rateau	1909	1,545	1500	188.5	581	28.59	0.654	12.97	16,230	263.0	396.3	66.4	*Zeit. D.V.D. Ing.*, 12/10/'10
Bergmann	Curtis-Rateau	1910	2,477	1500	140.0	522	28.81	0.588	13.93	17,135	244.8	373.4	65.6	*Elec. Zeit.*, 4/20/'11
A. E. G.	Curtis-Rateau	1908	4,239	1500	188.3	662	29.11	0.397	11.97	15,620	284.9	439.0	64.9	*Stodola, 4th ed., p.* 404
British Westinghouse	Curtis-Rateau	1911	2,930	1500	210.2	568	28.18	0.894	13.72	16,935	248.7	383.3	64.9	*Electrical Review*, 4/28/'11
A. E. G.	Curtis-Rateau	1907	3,169	1500	184.7	592	29.11	0.397	12.74	16,230	267.7	425.1	63.0	*Trans. A.S.M.E., vol* 32
M. A. N.	Curtis-Zoelly	..	2,507	1500	175.5	460	27.40	1.234	16.24	19,020	210.0	334.6	62.8	*Data from Manufacturer*
Bergmann	Curtis-Rateau	1909	1,562	1500	186.8	555	28.33	0.780	14.57	17,970	234.1	381.3	61.4	*Data from Manufacturer*
James Howden & Son	Zoelly	1909	6,383	1000	202.7	520	27.33	1.269	14.305	17,150	238.5	353.0	67.5	*Enginer, London*, 10/29/'09
M. A. N.	Zoelly	1910	1,400	3000	180.7	554	27.40	1.237	14.21	17,310	240.0	356.2	67.4	*Zeit. D.V.D. Ing.*, 12/10/'10
Escher, Wyss & Co.	Zoelly	1910	2,052	3000	193.9	585	28.39	0.750	13.04	16,290	261.5	392.6	66.6	*Zeit. F.D.G. Turb.*, 2/20/'11
Escher, Wyss & Co.	Zoelly	1910	4,189	1000	179.7	557	28.66	0.618	13.30	16,520	256.5	391.3	65.5	*Zeit. F.D.G. Turb.*, 2/20/'11
F. Ringhoffer	Zoelly	1908	3,000	1000	170.7	470	27.60	1.138	15.52	18,278	219.8	339.2	64.8	*Zeit. D.V.D. Ing.*, 12/10/'10
M. A. N.	Zoelly	1910	1,250	3000	182.1	582	28.82	0.540	13.09	16,500	260.2	404.5	64.4	*Zeit. D.V.D. Ing.*, 12/10/'10
Oerlikon	Rateau	1911	3,166	1500	213.9	663	29.25	0.367	11.44	14,970	298.2	450.6	66.1	*Engineering*, 10/20/'10
Escher, Wyss & Co.	Zoelly	..	5,118	1000	133.7	549	27.55	1.161	15.18	18,530	224.6	341.6	65.7	*Dinglers P.J.*, 7/15/'11
Escher, Wyss & Co.	Zoelly	1908	5,000	1000	166.4	539	26.38	1.736	16.13	19,350	211.2	330.4	63.9	*Zeit. D.V.D. Ing.*, 12/10/'10
Escher, Wyss & Co.	Zoelly	..	3,540	1500	155.1	469	28.21	0.838	15.07	17,940	226.3	349.5	64.8	*Dinglers P.J.*, 7/15/'11
Escher, Wyss & Co.	Zoelly	1910	1,641	3000	221.0	672	27.91	0.985	13.08	16,775	260.6	406.5	64.1	*Zeit. F.D.G. Turb.*, 2/20/'11
Escher, Wyss & Co.	Zoelly	1910	1,235	3000	176.8	451	28.39	0.750	15.35	18,156	222.3	357.8	62.2	*Zeit. F.D.G. Turb.*, 2/20/'11
British Thomson-Houston	Curtis	1911	2,987	1500	154.7	505	26.75	1.557	15.96	18,960	213.7	321.2	66.5	*Engineering*, 10/20/'11
Gen. Elec. Co.	Curtis	..	3,464	..	210.0	513	28.75	0.575	13.62	16,620	250.4	393.4	63.6	*Trans. A.S.M.E., vol.* 32
British Thomson-Houston	Curtis	1909	2,500	1500	126.5	414	28.47	0.711	15.92	18,590	214.0	336.1	63.7	*Zeit. D.V.D. Ing.*, 12/10/'10
A. E. G.	Curtis	1906	3,000	1500	191.3	590	29.05	0.427	12.79	16,240	266.6	420.4	63.4	*Zeit. D.V.D. Ing.*, 12/10/'10
A. E. G.	Curtis	1909	2,236	1500	191.6	654	29.34	0.284	11.77	15,450	289.8	455.8	63.6	*Zeit. D.V.D Ing.*, 12/10/'10
Gen. Elec. Co.	Curtis	..	8,880	..	192.5	487	28.02	0.933	15.05	17,965	226.7	359.5	63.1	*Trans. A.S.M.E., vol.* 32
British Thomson-Houston	Curtis	1911	1,541	1500	149.7	365	27.97	0.956	17.46	19,720	195.3	320.2	61.0	*Engineering*, 10/20/'11
Gen. Elec. Co.	Curtis	..	10,816	750	190.0	525	29.39	0.260	12.90	16,135	264.5	427.3	61.9	*Trans. A.S.M.E., vol.* 32
Gen. Eelc. Co.	Curtis	..	5,095	..	185.1	554	29.40	0.255	12.71	16,090	268.4	436.0	61.6	*Trans. A.S.M.E., vol.* 32
British Thomson-Houston	Curtis	1911	1,221	3000	134.7	448	27.16	1.353	17.75	20,690	192.2	314.0	61.2	*Engineering*, 10/20/'11
Gen. Elec. Co.	Curtis	1910	8,775	750	194.0	451	27.95	0.956	15.95	18,720	213.8	350.8	61.0	*Trans. A.S.M.E., vol.* 32

References: *Zeit. D.V.D. Ing.—Zeitschrift des Vereines Deutscher Ingenieure; Zeit. F.D.G. Turb.—Zeitschrift fur das Gesamte Turbinenwesen; Dinglers P.J.—Dinglers Polytechnisches Journal; Elec. Zeit.—Electrotechnische Zeitschrift.*

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS.

Concrete Costs. By Frederick W. Taylor and Sanford E. Thompson. Published by John Wiley and Sons. Canadian agents, Renouf & Co., Montreal. Cloth, size 5 x 8 in., 82 figures, 709 pages. Price $5.00 net.

This is the first attempt that has been made to present in book form a thorough and minute analysis of the times required for performing every separate operation in concrete construction, and the cost of all these operations each by itself, as shown by the cost records of a great number of jobs taken from the records of many large contractors. The authors, Frederick W. Taylor and Sanford E. Thompson, have been engaged for some seventeen years past in a study of the building trades with the idea of applying to these trades the methods of time study and scientific management which have been so notably successful in factories. It was thought at the outset that this investigation could be made in a comparatively short time, but the difficulties of making accurate time studies of men engaged in the numerous tasks of concrete construction proved to be very great. The active work of time study was carried out by Mr. Thompson and his assistants under the advice of Mr. Taylor, and the investigation already completed covers some half dozen of the building trades.

"Concrete Costs" is believed by the authors to be of special value to (1) architects, engineers and contractors in making accurate estimates of the costs of concrete works and structures; (2) contractors, superintendents and foremen, to help them to lay out and plan their work in such a way that their materials will be more economically handled and used than in the past, so that each workman shall do more and better work than heretofore; and (3 to assist in introducing the principles of scientific management in the building trades.

The distinctive feature of this book is that the information given in its tables, curves, etc., as to how long workmen, machines, and teams ought to take to do all kinds of tasks, has been done by careful timing with the stop watch of all these tasks as they were being done in the course of the day's work. Heretofore, the best knowledge of the time required to do work of this character has been obtained by keeping records of the pay, and sometimes of the time of gangs or groups of workmen while they were doing whole jobs of work, or at best, quite large sections of the contract. Such figures, however, because of the fact that no two contracting jobs are exactly alike has made it impossible for the contractor to make much better than a good guess of the cost of his next job.

Tested by the actual cost figures of various jobs, as shown by the contractors' records, the tables of this book have proved themselves very accurate, since the cost as estimated from the tables has agreed very closely with the costs of the actual work as carried out under the most efficient contractors' systems.

Chapters I. and II. of the book present and analyze as a guide for very rough estimates the approximate costs of miscellaneous concrete work as given in technical publications. Curves showing the approximate costs of reinforced concrete buildings of specified dimensions from one to six stories in height, are given in Chapter III. The next two chapters include the first of the unique contributions of the book in an account of the applications of the principles of scientific management to construction operation. Succeeding chapters treat of the proportioning of concrete: The labor costs of excavating, crushing and transporting materials, and mixing of concrete by hand and machine; management, including illustrations of plant equipment and layout on many actual jobs. Three chapters are given to the subject of forms, both for mass concrete, for arches, and for a wide range of reinforced concrete buildings. A great number of detailed tables present the cost of every element, of every operation in construction work under stated conditions, and with directions on the same page as the table for adapting each particular table to certain variations of wages and other conditions. Probably not all readers will agree with all of it, but a careful study of the book will probably convince everyone that it is the most important book on concrete that has appeared on this side of the water.

Design of Electrical Machinery. Vol. I. Direct Current Dynamos. By William T. Ryan, E.E., assistant professor of Electrical Engineering, University of Minnesota. New York, John Wiley & Sons; London, Chapman & Hall, Limited; Montreal, Renouf Publishing Co. Price $1.50 net.

"A Manual for the Use Primarily, of Students in Electrical Engineering Courses." Two subsequent volumes are to treat of alternating current generators, synchronous motors, rotary converters, and transformers.

A theoretically sound and practical work whose worth is enhanced by the author's sensible recognition that it is not the function of a college course to develop full-fledged commercial designers. The treatment presupposes the knowledge—or at least the simultaneous study—of the fundamental scientific principles involved, and confines itself to the presentation and illustration of a logical and well arranged method of practically applying such principles to specific problems of design. There are many practical tables and empirical formulae exemplifying modern commercial practice and the recommended procedure is such as should enable anyone with the requisite knowledge of fundamentals to produce successful operating designs. The author makes no claim to have furnished a substitute for the experience and special knowledge without which commercially successful designs are not to be expected. As a manual for beginners within or without the class room the volume should be extremely useful.—J.A.J.

Superheated Steam in Locomotive Service. (An abstract of publication No. 127 of the Carnegie Institution of Washington) by W. F. M. Goss, has just been issued as Bulletin No. 57 of the Engineering Experiment Station of the University of Illinois. Price 40 cents.

This bulletin gives a summary of foreign practice in the use of superheated steam; it contains a report of an elaborate series of tests made upon an American locomotive to determine the precise advantage to be derived from superheating under various conditions of locomotive service; and it shows that the use of superheated steam is not attended by serious difficulties. The superheater is easily maintained,

and its presence as a detail of locomotive mechanism introduces no new problems in maintenance. The superheater improves the efficiency of the locomotive through the saving of coal and water. Tests run with boiler pressures varying from 120 to 240 lb. per sq. in., for which the steam was superheated approximately 150° F., prove that neither the steam nor the coal consumption is materially affected by considerable changes in boiler pressure. This fact justifies the use of comparatively low pressures in connection with superheating. The saving in water consumption was found to vary from 18 per cent. at a boiler pressure of 120 lb. to 9 per cent. at a boiler pressure of 240 lb., the corresponding saving in coal varying from 17 per cent. to 6 per cent. between pressures of 120 and 240 lb. The power capacity of the superheating locomotive was found to be greater than that of a saturated steam locomotive of the same general dimensions.

A New Analysis of the Cylinder Performance of Reciprocating Engines. By J. Paul Clayton, has just been issued as Bulletin No. 58 of the Engineering Experiment Station of the University of Illinois.

The uses of the steam engine indicator have hitherto been limited to rather simple processes such as that of determining the indicated horse-power of an engine, or to that of settling valves. The investigation described in this bulletin discloses the fact that the indicator diagram constitutes sufficient evidence upon which to base an analysis of cylinder performance, the results of which have not heretofore been considered possible. The process involves the transferring of the indicator diagram to logarithmic cross-section paper, and the drawing of a figure called a logarithmic diagram. By the aid of this diagram, it has been found that the expansion and compression of all elastic media used in practice obey substantially the polytropic law $P V^n = C$. From this fact there have been developed rational methods of approximating the clearance of a cylinder, of closely locating the cyclic events, and of detecting moderate leakage with the engine in normal operation.

It has been discovered that the value of n in the law $P V^n = C$ is controlled directly in steam cylinders by the quality of the steam in the cylinders at cut-off, and that this relation of the value of n and the quality is practically independent of cylinder size and of engine speed for the same class of engine. From this fact there has been devised a method of computing the actual steam consumption of an engine from the indicator card alone, to within 4 per cent. of the consumption as measured by test.

Copies of Bulletin No. 58 may be obtained upon application to W. F. M. Goss, director of the Engineering Experimental Station, University of Illinois, Urbana, Illinois.

Bulletin No. 24, "The Economy Steam Turbine for Belt Drive," has just been published by the Kerr Turbine Co., Wellsville, N.Y. This bulletin shows belted economy turbine installations.

Note.—The book reviews will be continued in next week's issue.

NEW GOVERNMENT BUILDING.

The new government building at the Canadian National Exhibition is being rushed to completion and will be ready for the year's Fair. It will cost $160,000, of which the Dominion Government pays $100,000, the Ontario Government $25,000 and the city of Toronto the balance. It will be used for Provincial, Dominion and educational exhibits.

VALUE OF FOREST PRODUCTION.

The total value, at the point of production, of the annual forest products of Canada is at least $166,000,000. This is $22.44 for every person in Canada, March 31, 1909. In 1909, there were cut from Canadian forests about 400 cubic feet of timber for every inhabitant of the country. This is a per capita timber usage unequalled by that of any of the other important countries in the world.

CANADIAN ELECTRICAL ASSOCIATION.

The members of the above association held their twenty-second annual meeting in the city of Ottawa, June 19th, 20th and 21st last.

The members of the association were welcomed on behalf of the city by Controller Hinchey, acting mayor. The titles of the papers and those who delivered them were: "Recent Developments in Lamps and Reflectors," by J. G. Henninger, illuminating engineer, National Electric Lamp Association; "The Influence of Ice on Water Power Development," by Professor H. T. Barnes, D.Sc., F.R.S., McGill University, and "Distributing Systems for Outlying Districts and Smaller Points," by S. Bingham Hood, Toronto Electric Light Company. On each of the papers an interesting discussion took place, and in particular on that of Professor H. T. Barnes, Mr. J. Murphy, electrical engineer of the Department of Railways and Canals, showing a number of fine slides illustrative of the ice difficulty.

In the evening the delegates to the convention and their friends to the number of several hundred journeyed out of the Victoria Hotel at Aylmer, where they were the guests of the city at an informal dance and garden party.

Mr. Pack, of the Toronto Electric Light Company, was elected president, and Mr. T. S. Young is the honorary secretary.

PERSONAL.

MR. C. D. CAMPBELL has been appointed town engineer, of Galt, Ont., succeeding Engineer Fuce, who is going to Calgary to open a private office.

MR. F. S. HAM, of the firm of Ham, Baker and Company, Limited, London, England, visited Toronto last week. Mr. Ham is in Canada on a business trip.

DR. A. A. WEAGANT, Ottawa; DR. THOS. E. KAISER, Oshawa, and DR. HENRY R. CASGRAIN, Windsor, have been appointed to the Provincial Board of Health of the Province of Ontario.

MR. BION J. ARNOLD, Chicago, and MR. J. M. MOYES, Toronto, have been engaged by Corporation Counsel Drayton and Mayor Geary as traffic experts to report on a comprehensive street railway system for the city of Toronto.

MR. H. G. BURD, who for some time has been connected with the Standard Underground Cable Co., as sales engineer in the New York office, has been appointed assistant to the sales manager of the Standard Underground Cable Co., of Canada, Limited, with headquarters at Hamilton, Ont.

MR. WILLIAM H. MARSH, who for the past ten years has been connected with the Standard Underground Cable Co., of Pittsburg, Pa., in the capacity of superintendent of construction, has been appointed secretary and assistant treasurer and sales manager of the Standard Underground Cable Co., of Canada, Limited, with headquarters at Hamilton, Ont.

OBITUARY.

CAPTAIN KILLALY GAMBLE, R.A., late secretary-treasurer of the Association of Ontario Land Surveyors, is dead. His death occurred at Bournemouth, England.

He was born at Enniskillen, Ireland, educated at Portora school, and entered as a cadet at Woolwich, where he took a high stand. During his military career he served on duty at Dublin, Malta, Gibraltar, Halifax, Bermuda, and other British garrisons.

Invalided after sixteen years, he retired from the service and came to Canada in 1882. He then entered the profession of land surveying at Winnipeg, and later, having received commissions as Dominion Land Surveyor and Provincial Land Surveyor for Ontario, became established in Toronto. In 1886 Captain Gamble married Miss M. d'A. Killaly, youngest daughter of the late Hon. H. H. Killaly, and was predeceased by her two years.

During the year 1911 Mr. Gamble was president of the Engineers' Club of Toronto, and had many warm personal friends, not only in the city, but throughout the province and in the old land.

COMING MEETINGS.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithaca, N.Y.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN FORESTRY ASSOCIATION.—Convention will be held in Victoria, B.C., Sept. 4th-6th. Secy., James Lawler, Canadian Building, Ottawa.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Annual Assembly will be held at Ottawa, in the Public Library, on 7th October, 1912. Hon. Sec'y, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydonejack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton; Secretary-Treasurer, Mr. K W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. · Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President, J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Jas. Anderson, Gen. Mgr., Sandwich, Windsor and Amherst Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc.
Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close	Noted in issue of
7-3—Storm Drain, Orillia, Ont.	P. & S. 6-27
7-1—Boilers, pumps, Verdun, Que.	(S.) 6-27
7-15 Supply of electrical machinery and sewage disposal works, Battleford, Sask. .....(P. & S.) 6-27	
(Earlier plans and specifications are also on file at The Canadian Engineer Offices, Montreal and Winnipeg.)	

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Alert Bay, B.C., operating house, etc.	July 1.	June 20.	68
Arden, Man., bridge	July [illegible]	June [illegible]	[illegible]
Barrie, Ont., public buildings...	June 27.	June 13	[illegible]
Boswell, B.C., pile bent wharf.	July 2.	June 6.	[illegible]
Brundage's Point, N.B., wharf	July 2	June 20.	68
Cache Bay, Ont., wharf	July 10.	June 20.	68
Carr's Brook, N.S., breakwater wharf	June 27	June [illegible]	68
Calgary, Alta., motor generator.	June 26.	June 20.	[illegible]
Carleton Place, Ont., sewerage and water supply	July 9	June 20.	67
Elkholm, Man., industrial school buildings	July [illegible]	June 20.	67
Fort William, Ont., sewer	July 5.	June 13	67
Fort William, Ont., sewer, Marks Street	July 5	June 20.	[illegible]
Guelph, Ont., dairy barns	June 29.	June 20.	[illegible]
London, Ont., breakwater	June 27.	June 20.	80
Norwood, Ont., drill hall	July 3.	June 20.	67
Omemee, Ont., drill hall	July 2.	June 20.	68
Orillia, Ont., storm drain	July 3.	June [illegible]	[illegible]
Orillia, Ont., sanitary sewers ..	July 3.	June 20.	[illegible]
Ottawa, Ont., Hudson Bay Rly..	Aug. 1.	June [illegible]	80
Ottawa, Ont., wooden hopper scows	July [illegible]	June [illegible]	[illegible]
Ottawa, Ont., alterations to school buildings	July 12.	June 20.	68
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., sale of steamer...	July 3.	June 6.	[illegible]
Ottawa, Ont., design and construction of steamship	June 30.	May 16	76
Perry Point, N.B., dredging ..	June 26.	June 20.	68
Port Arthur, Ont., dredging....	July 2.	June 20.	[illegible]
Port of Quebec, Que., proposals for dredging	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31	Feb. 7.	60
Point Edward, Ont., operating house	July [illegible]	June 13	[illegible]
Quebec, Que., leasing of water-powers	June 26	May 2	72
St. Catharines, Ont., trunk sewer	July 3.	June 13.	80
Toronto, Ont., high level interceptor	July 2	June 13	80
Toronto, Ont., reinforced concrete girder bridge	July 2	June 20.	80
Toronto, Ont., opera chairs....	July 22.	June 20.	[illegible]
Toronto, Ont., water main, Front Street	July 2.	June 20	[illegible]
Vancouver, B.C., bridge con- [illegible]	July 8	May 30	72
Verdun, Que., boilers	July 1.	June 20.	72
Windsor, Ont., quarantine [illegible]	July 8	June [illegible]	[illegible]

TENDERS.

Arthur, Ont.—Tenders will be received by Mr. D Brocklebank up to noon of June 28th for the construction o five reinforced concrete girder bridges for the County o Wellington, near Arthur. Plans, etc., at the office of Messrs Bowman and Connor, engineers, 36 Toronto Street, Toronto

Battleford, Sask.—Tenders will be received by J. P Marshall, secretary-treasurer of the town of Battleford, Sask, until noon of July 10th, 1912, for the supply and delivery o machinery and materials for the erection of generators, ex citers and switchboard, pumps and motors, power house an reservoir, sewage disposal works, supply and delivery of stee water pipe and specials, trenching and laying steel wate pipe, etc., two pneumatic storage tanks. Plans and specific ations may be seen at the offices of The Canadian Engineer [illegible]nipeg, Toronto and Montreal, at the office of the Battle ford town engineer and electrical engineer, and at the offic of Messrs. McArthur, Murphy and Underwood, consultin engineers, Bottomley Block, Saskatoon. (See advt. in Cana dian Engineer.)

Carleton Place. — The Sewers and Water Commissio will receive tenders up to noon of July 9th, 1912, for the sup ply of all materials and construction of about five miles o sewers, and five miles of water mains. Plans and specifica tions may be seen at the offices of the consulting engineer Toronto, or the office of B. G. Michel, Carleton Place, Ont T. Aird Murray, 303 Lumsden Building, Toronto, consult ing engineer. (See advt. in Canadian Engineer.)

Estevan, Sask.—Tenders will be received until July 9th 1912, for the construction of the following works:—

Contract "A"—Water works force main.
" "B"—Water works pump house.
" "D"—Water pipes.
" "G"—Pumping machinery.
" "[illegible]"—Pump well.
" "O"—Outfall sewer.
" "X"—Sewage disposal works.

Plans and specifications may be seen at Estevan, or at th engineer's offices. L. A. Duncan, Esq., secretary-treasure Estevan; Chipman and Powers, engineers, Toronto an Winnipeg.

Estevan, Sask.—Tenders will be received by H. N Scott, Esq., secretary-treasurer, High School Board, up t noon of July 10th, 1912. Plans and specifications may b seen at the office of Storey and Van Egmond, Architects Regina, Sask., and at the office of the Secretary-Treasurer.

Guelph, Ont.—Tenders for the construction of a 70 x 1 ft. steel bridge at Rockwood, concrete abutments for same and for a reinforced girder bridge near Elora, will be re ceived by J. W. Sutton, Esq., Court House, Guelph, unt June 29th, 1912.

Guelph, Ont.—Tenders will be received until July 5th 1912, for the following works:—

1. Concrete work on a combined bridge and dam on th River Credit, at the paper mills, Georgetown.
2. For the steel beam superstructure of the abov bridge.
3. For the concrete abutments and floor for a steel high way bridge, 100-ft. span, over the River Credit, on the 10t line, Esquesing Township.

4. For the steel superstructure of the above bridge.

5. For the construction of a concrete abutment under Capias Bridge in Glen Williams.

Plans and specifications at the Paper Mills, Georgetown, at the office of Mr. Moore, Reeve of Georgetown, or at the office of Malcolm and Rudd, Metropolitan Bank Building, Guelph. J. Hutcheon, Engineer, Guelph. (See advt in The Canadian Engineer.)

High River, Alta.—Tenders will be received by Geo. E. Mack, Esq., secretary-treasurer, High River, until July 16th, 1912, for the following works:—

Contract "B"—Pump house.
" "G"—Pumping machinery.
" "I"—Pump well.
" "P"—Ejector station.
" "X"—Sewage disposal works.

Plans and specifications may be seen at High River or at the offices of Messrs. Chipman and Powers, engineers, Toronto and Winnipeg, after June 29th.

Kindersley, Sask.—Tenders will be received until July 22nd, 1912, for the supply and delivery of waterworks and electric light equipment. Specifications, etc., at the office of the Engineers, The John Galt Engineering Company, 317 Portage Avenue, Winnipeg. D. MacTavish, Secretary-Treasurer, Kindersley. (See advt. in The Canadian Engineer.)

Kingston, Ont.—The Government will call for tenders shortly for the construction of the temporary bridge over the Cataraqui River, to take the place of the present structure until such time as the new bridge is completed.

Moose Jaw, Sask.—Tenders will be received until noon of July 10th, 1912, for water gates for high pressure distribution pipes. Plans, etc., may be obtained at the office of the City Commissioners, Moose Jaw, where tenders will be received.

North Battleford, Sask.—Tenders for the construction of a pump well will be received by H. W. Dixon, Esq., secretary-treasurer, until July 2nd, 1912. Plans and specifications may be seen at North Battleford, or at the office of the engineers, Messrs. Chipman and Powers, Toronto and Winnipeg.

North Toronto, Ont.—Mr. F. How, Chairman Board of Works, will receive tenders up to noon, Tuesday, July 30th, 1912, for the construction of pavements and storm sewers. (See advt. in this week's issue The Canadian Engineer.)

Ottawa, Ont.—Tenders will be received until July 4th, 1912, for the construction of a wharf at Needles, B.C. Plans, etc., at the offices of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.; C. C. Worsfold, district engineer, New Westminster, B.C.; postmasters at Needles and Victoria, B.C.

Ottawa, Ont.—The Department of Public Works will receive tenders until July 2, 1912, for dredging required at St. George, N.B. Full particulars may be obtained from the Secretary, Department of Public Works.

Ottawa, Ont.—The Department of Militia and Defence will receive tenders up to noon of July 10, 1912, for the construction of a rifle range at St. Catharines, Ont. Full particulars at the offices of the officer commanding the 2nd Division, Toronto, Ont.; Lt.-Col. W. W. Burleigh, O.C. 19th Regiment, St. Catharines; and the Director of Engineer Services, headquarters, Ottawa.

Prince Albert, Sask.—Tenders for sewage pumps will be received by the City Commissioners up to noon of July 12th, 1912. Specifications and plans may be obtained at the office of the City Engineer. C. O. Davidson, city clerk. (See advertisement in The Canadian Engineer.)

Peterborough, Ont.—Tenders will be received until June 27 for the erection of a fire-proof addition to the Nicholls Hospital. Also a laundry building. Plans and specifications can be seen at the office of W. Blackwell, architect, Water Street. John Crane, secretary.

Port Hope, Ont.—Mr. Henry White, secretary Library Board, will receive tenders up to noon of July 5th for the several trades in connection with the erection of a library. Plans and specifications at the library building, Port Hope, or at the office of W. A. Mahoney, architect, Telephone Building, Guelph, Ont.

Regina, Sask.—Tenders for the trenching and laying of sewer mains on certain streets in the city will be received by the City Commissioners until June 27, 1912. Plans, etc., at the office of the City Engineer. L. A. Thornton, City Commissioner.

St. Charles, Man.—Tenders will be received until July 6th, for the construction of a trunk sewer on Ferry Road. Plans, and specifications, with full information may be obtained at the office of the Municipal Engineer, Municipal Hall, St. Charles. Frank Ness, Treasurer, Kirkfield Park P.O., Man.

St. John, N.B.—The city of St. John invites tenders for the following works, viz.: Excavation, backfill and cartage for water main in Milford Road; excavation, backfill and cartage for main sewer in St. John Street West. Plans, etc., at the office of the City Engineer, No. 5, City Hall. Rupert Wigmore, Commissioner of Water and Sewage.

Stratford, Ont.—The Board of Works intend to call for tenders immediately for the Remeo Creek scheme.

Toronto, Ont.—Tenders will be received until noon of July 4th, 1912, by W. W. Scott, Esq., township clerk, Moorefield, for the construction of a steel bridge of 110 ft. span over the Connestogo River, also for concrete abutments for the same. Plans and specifications at the office of the clerk or Bowman and Connor, engineers, 36 Toronto Street, Toronto.

Watrous, Sask.—Tenders will be received by Joseph Gaye, secretary-treasurer, of the town of Watrous, for the following works:—

Contract A—All labor and certain materials necessary for the laying water pipes and sewers.

Contract B—All labor and materials necessary for the construction of pump house.

Contract C—This contract will be subdivided as follows:—

1—Furnishing materials and labor for and erecting steel water tower.

2—Furnishing materials and labor for and constructing concrete foundation for water tower.

3—Furnishing material and labor for and constructing frame housing for water tower.

Contract D—Furnishing cast-iron water and special castings.

Contract E—Furnishing gate valves, fire hydrants, etc.

Contract G—Furnishing and erecting pumping machinery.

Contract I—Furnishing material for and constructing collecting galleries and suction well.

Contract S—Furnishing sewer pipes and junctions.

Contract T—Furnishing labor and material for concrete walks.

Tenders will be received until July 15th, 1912, for Contracts A, C, D, E, S and T, and until July 31st, for Contracts B, G, and I.

Plans, etc., may be seen at the Town Hall, Watrous, or at the Engineers' Offices, Winnipeg and Toronto, on or after July 1st. Messrs. Chipman and Powers, engineers.

Weston, Ont.—The Municipal Council of the Village of Weston will receive tenders up to noon of July 8th, 1912, for the supply of all materials and the construction of sewerage and storm water drainage. Plans and specifications at the office of T. Aird Murray, consulting engineer, 303 Lumsden Building, Toronto. J. H. Taylor, clerk, Weston. (See advt. in Canadian Engineer.)

Winnipeg, Man.—Tenders will be received by the Chairman, Board of Control, until July 15th, 1912, for the supply for a quantity of 12-inch cast-iron water pipe and specials, hydrants and gate valves for extension of the fire service waterworks. Specifications, etc., at the office of the City Engineer, 223 James Avenue. M. Peterson, Chairman, Board of Control Office, Winnipeg.

CONTRACTS AWARDED.

Charlottetown, P.E.I.—Messrs. Clark and Morrison have received the contract for the erection of a railway station to cost $30,000 for the Federal Government, Ottawa

Dartmouth, N.S.—Messrs. F. A. Ronnan and Co., of Halifax, have the contract for the erection of a three-story brick and stone hospital to cost $80,000. Mr. Herbert E. Gates, architect, Telephone Building, Halifax, N.S.

Moose Jaw, Sask.—The Canada Foundry Company, Winnipeg, have been awarded the contract to supply a number of hydrants for the municipality. Messrs. Drummond,

Tarvia

Preserves Roads
Prevents Dust~

Tarvia Modern Pavement in Mount Pleasant Cemetery, Toronto.

Why this Cemetery Wants More Tarvia.

IN 1909, Mount Pleasant Cemetery, Toronto, built some beautiful roads with "Tarvia X," according to our Modern Pavement Specification. Cemetery roads get hard use from the heavy loads incident to the transportation of monuments, and ordinary macadam fails under such crushing strains. The tarviated macadam, being slightly plastic, is improved by such rolling.

Ordinary macadam is not clean enough for pedestrian processions in cemeteries, but a tarviated surface produces no dust or mud and is clean and firm immediately after a rain, shedding water as promptly as a good tar sidewalk.

Tarvia also reduces maintenance expenses, because it wears better than plain macadam under traffic and resists water action on grades.

After three years' trial of Tarvia, the cemetery authorities are paying it the truest kind of testimonial, namely, a repeat order, as per the following letter:—

Toronto, Ont.

Dear Sirs:

I wish to let you know we will require "Tarvia X" to build about 6500 yds. of road this year, about the end of July.

I may say that we are well pleased with our Tarvia roads. The first that were made in 1909 have stood the test of traffic and heavy loads up to 16 tons—the wagon wheels leaving no impression.

Where our roads have a 7% grade we find the Tarvia fills the bill; no washing, no dust, easy to sweep and clean in wet weather.

(Signed) W. H. FOORD, Supt.

Tarvia is made in three grades:

"Tarvia X" for use in constructing roads and pavements.

"Tarvia A" for hot surface applications.

"Tarvia B" (applied cold) for dust prevention and road preservation.

Booklets regarding Tarvia will be sent free on request.

The Paterson Manufacturing Co., Limited
MONTREAL TORONTO WINNIPEG VANCOUVER

The Carritte-Paterson Manufacturing Co., Limited
ST. JOHN, N.B. HALIFAX, N.S.

McCall Company of Montreal will supply a number of valves.

Newmarket, Ont.—Mr. J. J. McIntosh, of Alexandria, Ontario, has been awarded the contract for the erection of a Public school at a price of $21,760.

Toronto, Ont.—Messrs. Ross and MacFarlane, of Montreal, are the winners of the competition of the Board of Education for suitable plans for the new technical high school. Messrs. Brown and Vallance, of Montreal, and C. S. Cobb, of Toronto, came second and third respectively.

Toronto, Ont.—Messrs. Deaks and Hinds, of the Toronto Construction Company, have been awarded the contract for the proposed double-tracking of the C.P.R. between Sudbury and Port Arthur. Ten million dollars is the estimated cost of construction.

Toronto, Ont.—The National Iron Works, Toronto, has applied for a permit from the City Architect for alterations and additions to the pipe foundry on Cherry Street. The building is to be of concrete and steel and will cost $50,000. Mr. Gordon F. Perry is general manager.

Toronto, Ont.—Messrs. R. Weddell and Company, of Trenton, Ontario, have been awarded a contract calling for dredging in the harbor of this city.

Vancouver, B.C.—Mr. W. H. Rourke, Vancouver, has received the contract for the construction of the new lighthouse tower to be constructed at Point Atkinson. The structure will be of concrete and about forty-five feet high. Total cost will be about $15,000.

Vancouver, B.C.—Mr. Wm. O'Dell has the contract for the erection of a six story brick building for the Vancouver Realty Company. The cost of the building will be approximately $40,000.

Western Ontario.—Messrs. Deeks and Hinds, of Toronto, have received a contract from the Canadian Pacific Railway to double track the line for sixty miles between Sudbury and Port Arthur.

Winnipeg, Man. — The Provincial Government have awarded the contract for the construction of the new law courts to the National Construction Company. The amount of the tender was $760,000.

RAILWAYS—STEAM AND ELECTRIC.

Kingston, Ont.—The Grand Trunk Pacific Railway has placed an order with the Canadian Locomotive Works for 15 locomotives.

Niagara District, Ont.—A report states that the Niagara, Welland and Lake Erie Electric Railroad will construct and operate a new line between Welland and Port Colborne within the next few months. Mr. C. J. Laughlin is general manager of this company.

Ottawa, Ont.—The Board of Railway Commissioners have postponed a meeting called for July 2nd next to July 3rd.

At this meeting railway companies will be asked to show cause why a general order should not issue requiring railway companies to furnish a heated car service.

Toronto, Ont.—Both Queen Street and King Street subway are to be reconstructed within the next year by the Grand Trunk Railway.

Toronto, Ont.—The Ontario Railway Board has ordered the management of the Toronto Suburban Railway to rebuild their line on Bathurst Street and Davenport Road, and lay a pavement between the rails and eighteen inches on either side.

Western Canada.—A report emanating from Montreal states that there is a probability of the Canadian Pacific Railway electrifying their lines through the Rocky Mountains upon completion of the double track.

EXTENSION TO NATIONAL IRON WORKS.

The National Iron Works of Toronto, has received a permit for an extension to its pipe foundry. The extension will cost in the neighborhood of $250,000, the contract having been let to the Eastern Construction Company. With this enlargement the company will be in a better position to take care of the greatly increased orders for cast-iron pipe.

LIGHT, HEAT AND POWER.

Brantford, Ont.—Arbitration without any conditions attached whatever has been decided on between the city and Cataract Power Co., over local rates. The agreement between the city and the company will form the basis of the arbitration, the chief point to settle being whether hydro-electric municipalities are securing power and light at a lower rate than Brantford.

Edmonton, Alta.—The public works commissioners and the light, heat and power commissioners will confer on a report submitted by J. M. Brodie on the matter of a municipal gas plant. The report gives the two following alternatives, one of which makes a total of $700,000, which would provide for, in addition to the central generating station, 65½ miles of gas mains: 44 on the north side, and 21 on the south side. This amount would cover the expenditure for possibly four years. The other alternative was for a total of $465,485, which, in addition to the central generating station, would give 26 miles of distributing mains; 20 miles on the north side and 6 miles on the south side.

Kindersley, Sask.—The municipal council will install an electric light system. The John Galt Engineering Company, Winnipeg, Man., are interested in the scheme.

Lethbridge, Alta.—The financial statement of the municipal electric and street railway departments to the end of April is given as:

Month	Receipts.	Expenditures.
January	$10,733.82	$ 5,059.31
February	9,755.22	5,535.45
March	8,449.57	4,279.35
April	8,614.07	3,819.61
	$37,552.68	$18,693.72

This leaves a profit of $18,858.96. Deducting $11,911.86 for interest and sinking fund, a net profit for the four months is left amounting to $6,947.10.

In the power house there has been generated 577,540 K.W.H. for the four months and 113,560,000 gallons of water pumped.

GARBAGE, SEWAGE AND WATER.

Winnipeg, Man.—The municipal engineering department are about to commence work on a system of high pressure water mains.

Kindersley, Sask.—The town council have decided to install a waterworks taking the supply from a dam located about a mile to the south of the municipality. The John Galt Engineering Company, Winnipeg, Man., are interested in the scheme.

BUILDINGS AND INDUSTRIAL WORKS.

Collingwood, Ont.—The Dominion Government will construct an efficient biological laboratory to be used in connection with the whitefish hatchery to be erected at an early date.

Edmonton, Alta.—Plans and specifications are now being prepared by Messrs. Van Siclen and MacComber for a ten story hotel to be erected on Peace Ave. The cost of this structure will be about $350,000. Mr. E. W. Chambers is representing a syndicate that are supplying the capital for this enterprise.

Guelph, Ont.—There is a strong probability of the Dominion Casket Company locating a plant in this city.

Halifax, N.S.—A report states that the Canadian Pacific Railway will erect a large hotel in this city.

Hespeler, Ont.—The Dominion Government will erect a new post office at a cost of $10,000.

Medicine Hat, Alta.—A report states that the management of the Canada Cement Company are contemplating the erection of a million dollar plant in this city for the purpose of meeting the demands of Western Canada.

Montreal, P.Q.—The municipal council will erect one public lavatory on Jacques Cartier Square, and if the same proves successful five or six more will be constructed.

48 in. CONTINUOUS STAVE LINE.

Manufacturer of

Galvanized Wire Machine Banded

WOOD STAVE PIPE

CONTINUOUS STAVE PIPE

RESERVOIR TANKS

For City and Town Water Systems, Fire Protection, Power Plants, Hydraulic Mining, Irrigation, etc.

Full particulars and estimates furnished.

PACIFIC COAST PIPE COMPANY, LTD.

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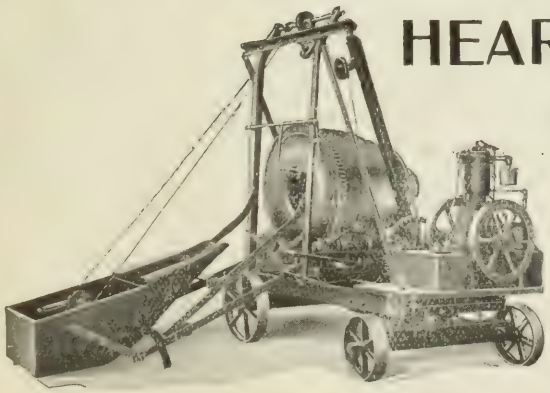
WETTLAUFER

HEART-SHAPED MIXER



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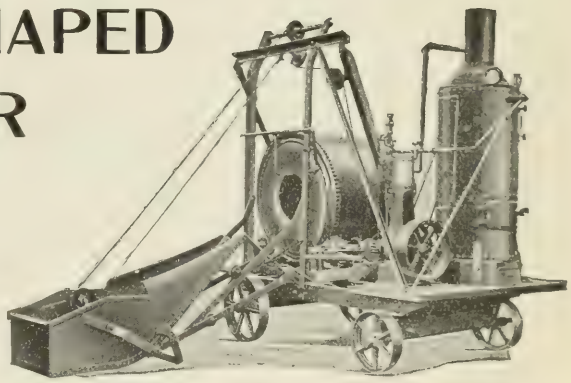

A MIXER is not COMPLETE unless it is equipped with **AUTOMATIC HOPPER, AUTOMATIC POWER DUMPING DEVICES,** and built of **STEEL** and **SEMI-STEEL** as used in the entire construction of our mixers throughout.

The famous heart-shaped drum turns the batch end for end very quickly; this ensures positive mixture.

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Head Office and Ware-rooms

178 SPADINA AVENUE,

WORKS AT MITCHELL, ONT. **TORONTO.** DETROIT, MICH. BUFFALO, N.Y.

A. R. WILLIAMS MACHY. CO.,
15 Dock Street,
St. John, N.B.

WETTLAUFER BROS.
316 Lagauchetiere St., W.,
Montreal, Que.

Mr[illegible]al, P.Q.—A report states that the Canadian Northern Railway, by reason of recent purchases, intend to make extensions to the Moreau Street Station. The yards at this point will be enlarged to twice their present capacity.

Moose Jaw, Sask.—There is a probability of a new immigration hall being erected in this city.

Port Colborne, Ont.—Work has started on the new plant of the Canadian Union Furnace Company.

Regina, Sask.—Messrs. Storey and Van Egmond have prepared plans for a new steam laundry to be erected for Messrs. Whitmore Bros. The building will be 50 x 100 feet of brick and steel construction, 3 stories, and the cost will be about $100,000.

St. Catharines, Ont.—The damage to the Welland Canal by reason of the recent accident will amount to $7,000.

Toronto, Ont.—The management of the Adams Harness Manufacturing Company have purchased a site on Logan Avenue, and on the same will erect a factory for the manufacture of blankets and horse collars.

Vancouver, B.C.—Mr. A. G. Ferra, Italian Consul, will erect a six story apartment house on Hastings Street. It will be of brick and terra cotta 50 x 122 feet. Mr. F. H. Perkins, of Vancouver, B.C., is the architect.

Vancouver, B.C.—Mr. W. McPherson is erecting a four story mill construction warehouse 100 x 50 feet. Messrs. Townsend and Townsend are the designers.

Victoria, B.C.—Mr. Jesse M. Warren has prepared plans for a church building to be erected by the congregation of the First Baptist Church. The materials are pressed brick and cut stone. The structure will cost about $100,000.

BRIDGES, ROADS AND PAVEMENTS.

Dauphin, Man.—The engineering department of this municipality will shortly call tenders for the superstructures of eight bridges. Mr. J. A. Gorby is secretary-treasurer of this town.

Hull, P.Q.—The City Engineer, J. P. A. Laforest, is preparing plans for a concrete bridge to replace the present structure at the pump house. The bridge will have a length of fifty feet and will cost about $1,500. If the plans are approved by the council the work will be commenced this season.

Irishtown, N.B.—The provincial Public Works Department will erect a new concrete bridge and undertake considerable road work in this section.

Lindsay, Ont.—The municipal council will call tenders for cement sidewalks.

Listowel, Ont.—The municipal council are considering the matter of street paving, and it is probable that tenders will be called in the near future. W. Climie is mayor of this town.

St. Catharines, Ont.—The municipal council have decided to construct a concrete bridge, 800 feet in length, across the old canal. The cost of this work will be $65,000. R. D. Brown, City Engineer.

St. Catharines, Ont.—Property owners in the vicinity of St. Paul Street will petition the municipal council to have a bridge constructed across Lock No. 3 of the Welland Canal.

Toronto-Hamilton, Ont. — A committee composed of W. A. MacLean, E. A. James, A. F. McCallum, W. D. Platt and Mayor T. L. Kennedy, president of the Good Roads Association, will secure information as to the best class of pavement and the probable cost of constructing a permanent highway between these two cities.

York County, Ont.—The County Council have adopted a by-law to raise $50,000 for the continuance of the bridge building programme.

FIRES.

Canning, N.S.—The business section of this town was sadly damaged by fire. The loss is estimated at $100,000.

CURRENT NEWS.

Montreal, P.Q.—A section of the pavement on Sherbrooke Street gave way beneath a steam roller weighing twelve tons engulfing the machine to a considerable depth. This is the third time that a similar accident has happened on this street, an automobile and a steam wagon being in the former mishaps.

North Toronto.—Mr. E. A. James, engineer of this municipality, has prepared the following estimates as a guide to the ratepayers voting on the question of double tracking the lines of the Metropolitan Railway:—Storm sewer, $25,000; curbing both sides, $14,520; paving, $155,200; special foundation under rails, $72,000; total, $266,720.

Toronto, Ont.—At the meeting of the Ontario Municipal Association which met in this city last week, Mayor George H. Lees, of Hamilton, was elected president of the association. Other officers were elected as follows: Vice-presidents, J. G. Richter, London; W. A. Clarke, York Township; Mayor G. J. Thorp, Guelph; R. C. Chown, Belleville; and W. Lane, Goderich; secretary-treasurer, K. W. McKay, St. Thomas; Executive Committee, Mayor Geary, Toronto; Mayor Lemon, Owen Sound; W. B. Doherty, St. Thomas; City Solicitor Wm. Johnstone, Toronto; F. R. Waddell, K.C., Hamilton; J. H. Dewey, Brockville; A. K. Bunnell, Brantford; Dr. Fairbank, Petrolea; S. Baker, London; S. R. Armstrong, Peterboro; S. H. Kent, Hamilton, and W. C. Campbell, St. Thomas.

TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ending June 10th, 1912:—

A Manchester firm of printing, stationery and advertising contractors are desirous of acting for Canadian firms who may wish to open business in Great Britain.

An Australian merchant house at present importing large quantities of United States goods of various descriptions, is prepared to do business with Canadian manufacturers.

A London correspondent desires to obtain agencies for the sale of Canadian goods.

A London firm make inquiry for the names of Canadian manufacturers of baking powder open to import supplies of tartaric acid, cream of tartar and citric acid.

A German firm interested in a patent potato digging machine desire to appoint reliable Canadian agents.

From the branch for city trade inquiries, 73 Basinghall Street, E.C.:—

A London company manufacturing athletic goods, and also leather travelling bags and trunks, and similar lines are desirous of finding a resident Canadian representative to act for them upon a commission basis.

CANADIAN NORTHERN RAILWAY WORK FOR 1912.

The following is an itemized list of the principal works on the construction programme of the Canadian Northern Railway:

Number of miles to be started this year, 1,053 miles.

Location of lines in actual construction this year:

Montreal to Hawkesbury, 58 miles.

Ottawa to Ottawa River, 32 miles.

West from Ruel, Ont., 100 miles.

East from Port Arthur, 108 miles.

Branch lines, and extensions in Alberta and Saskatchewan, 400 miles.

British Columbia, 75 miles.

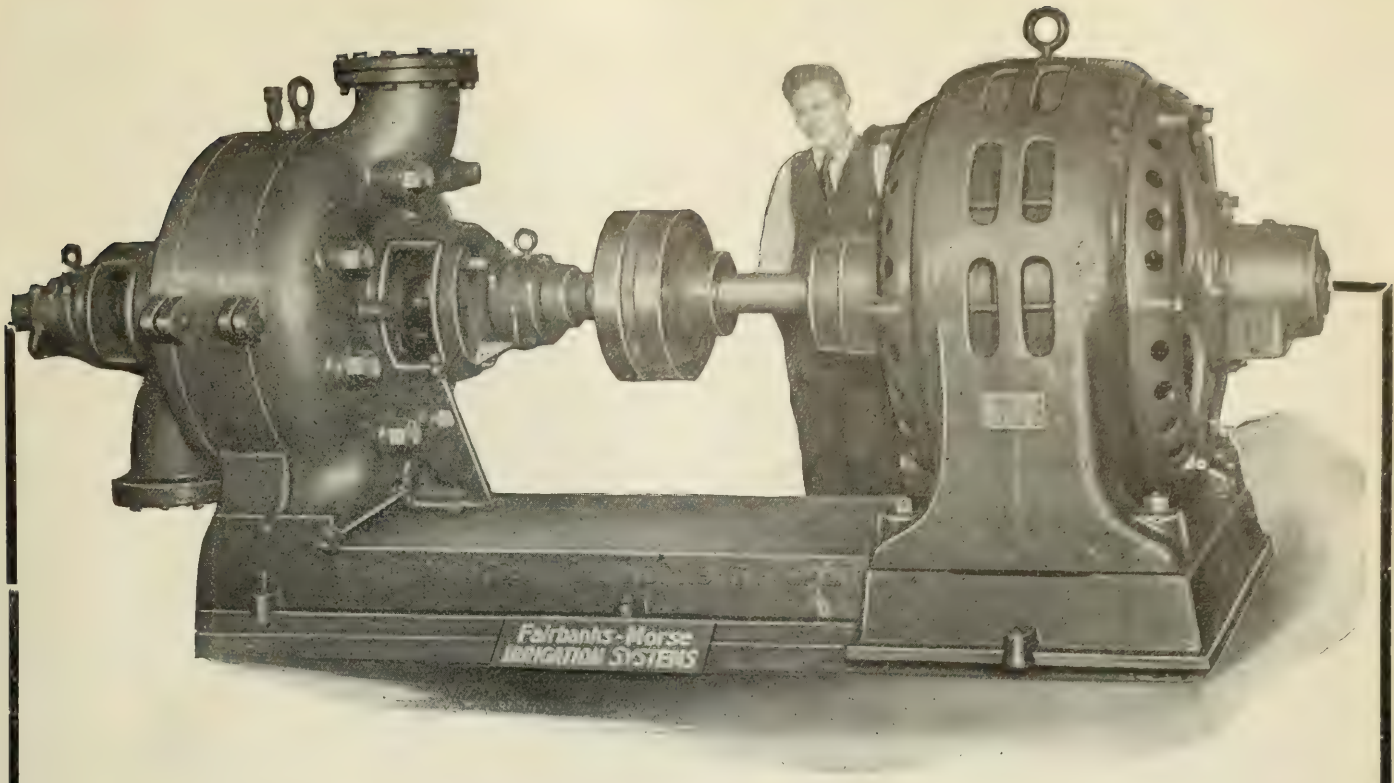
Sydenham, Ont., to Ottawa, 80 miles.

Relaying track on main line west, 200 miles.

Approximate number of men employed on construction, about 20,000.

Approximate amount of steel required for new tracks this year, 125,000,000 pounds.

Amount of new equipment to be installed this year, estimated cost, $8,000,000 to $9,000,000, including 136 engines, 4,050 box cars, 1,184 flat cars, 400 convertible construction cars, 70 cabooses, 6 snow plows, 1 rotary plow. 82 passenger cars, 35 mail and baggage cars, 3 dining cars, 4 parlor cars, 16 sleepers.



The Largest Direct Connected Centrifugal Pumping Unit in British Columbia.

The Vancouver Power Company have recently installed at their works at Coquitlam Dam, B.C., the largest direct connected centrifugal pumping unit in British Columbia. This outfit is to operate in parallel with a number of other pumps that are to furnish water under pressure for sluicing into place the material for their new dam.

This pump is a 10-inch, class "F," two-stage centrifugal, with bronze inpellers and renewable bronze diffusion vanes. It has a normal capacity of 1833 imperial gallons per minute when operating at 1160 r.p.m. against a total head of 355 feet or an equivalent pressure of 154 lbs. per square inch. It is mounted on a common sub-base with a 300 h.p. type "B," Fairbanks-Morse squirrel cage, induction motor, 2200 volts, 60-cycle, 3-phase, 1160 r.p.m. at full load, being direct connected thereto by means of a flexible leather link coupling

The motor possesses a feature in rotor construction that is unique. The end rings are welded on to the rotor bars by a new process, making a perfect joint, free from the troubles common to the purely mechanical or riveted joint, such as oxidation, working loose, and solder-throwing. This improvement marks a long step forward in the elimination of rotor trouble.

Our Vancouver Branch supplied and assembled this complete pumping unit. We are in a position to quote on the necessary equipment for any pumping requirements on receipt of specifications.

The Canadian Fairbanks-Morse Co., Limited

Fairbanks Standard Scales, Fairbanks-Morse Gas Engines
Pumps Safes Vaults

MONTREAL, ST. JOHN, OTTAWA, TORONTO, WINNIPEG,
CALGARY, SASKATOON, VANCOUVER, VICTORIA.

BACK COPIES OF ENGINEER WANTED.

One copy of The Canadian Engineer of the following dates are required. The usual extension of the sender's subscription will apply in this case: April 4th, 1912; January 5th, 1911; March 23rd, 1911.

SILVER IN NEWFOUNDLAND.

A silver miner, lately returned to his home at North Shore, Cape Breton, from the west is said to be about to undertake the examination of what appears to be a valuable silver deposit in Newfoundland not far from the tide water. The shipping facilities are excellent and a river capable of yielding 4,000 horsepower for the generation of electricity for use in the mine milling of the ore and smelting on the ground is available on the property.

CEMENT IN WESTERN CANADA.

Up to the middle of June about 100,000 barrels of cement have been ordered from the United States from the province of Alberta.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16710—June 4—Approving revised rule relating to Baggage of Excess Size as follows:—"Commencing July 1st, 1912, for any piece of baggage of any class (except immigrant baggage checked at port of landing, and whips in canvas or leather cases), the greatest dimension of which exceeds forty-five inches, there will be an additional charge for each additional inch equal to the charge for five pounds of excess baggage."

16711—June 7—Authorizing G.T.R. to construct additional team tracks along and across Esplanade St., Toronto, Ont.

16712—June 8—Authorizing C.N.O. Ry. to cross public road on Lot 11, Range 2, Twp. of Clarendon, Ct. Pontiac, Que.

16713—June 8—Authorizing C.P.R. to open for carriage of traffic double track from mileage 92.4 to Carberry, Man., at mileage 105.7, Manitoba.

16714-15—June 6—16716—June 5—16717—June 7—Authorizing C.P.R. to construct spur for T. D. Robinson and Sons, Winnipeg, Man., for M. Rumely Company, Saskatoon, Sask., for International Harvester Co., Lethbridge, Alta., and for Three Rivers Harbor Commissioners, at Bureau Wharf, Three Rivers, Que.

16718—June 8—Authorizing C.P.R. to cross Saskatchewan Ave., Edmonton, Alta., by overhead bridge and across Hardisty Avenue, by grade crossing.

16719—June 1—Approving location of Lake Erie & Northern Ry. from Grand River to Colborne St., Brantford, Ontario.

16720—June 10—Approving change in location C.P.R. station at Vancouver, B.C.

16721—June 10—Authorizing C.N.O. Ry. to open for carriage of traffic its line from Trenton to Deseronto and rescinding Orders 15211 and 15940, Oct. 28, and Feb. 13th, 1912.

16722—June 14—Directing G.T.R. to re-locate loading siding east of Vineland Station, Ont., and to erect fruit shed.

16723—June 11—Approving location of Algoma Eastern Ry. Co. across Little Current Channel, between mileage 79.80 and 80.69, Ontario.

16724—June 4—Approving plans of G.T.P. Ry. for freight shed at Mission Terminals, Fort William, Ont.

16725—June 11—Approving plan of C.P.R. (G. B. & S. Ry.) for interlocker in swing bridge over Trent Canal, mile 44, Ont.

16726—June 13—Approving plan of Kettle Valley Ry. for 250-foot deck-span over Trout Creek, near Penticton, B.C.

16727—June 8—Authorizing G.T.P. B.L. Co. to open for carriage of traffic its Tofield-Calgary Branch from Red Deer, mileage 83.5 to Trouch, mileage 121.4, Alberta.

16728—June 10—Authorizing G.T.R. and approving stress sheets of Bridge 189, and No. 77 Northern Division and Ottawa Division, Ontario.

16729-30—June 10—Relieving V. V. & E. Ry. from erecting and maintaining fences from Blaine to Colbrook, and from Colbrook to Brownsville, British Columbia.

16731—June 11—Extending until July 15, 1912, time for C.N.R. to put tracks at Saskatoon, Sask., in good shape, etc.

16732-33-34—June 11—16735—June 10—Directing Dominion Atlantic Railway to within 60 days to install improved type of electric bells at four street crossings in town of Windsor, N.S. 20 per cent. of cost of same from Railway Grade Crossing Fund.

16736—June 11—16737—June 13—Approving revised location of C.N.O. Ry. through Township of Torbolton and Fitzroy, Ct. Carleton, Ont., mileage 27 to 37.01 from Ottawa; and through Twps. of Fitzroy and Onslow and Bristol, Ct. Pontiac, Que., mileage 36 to 40 from Ottawa, Ontario.

16738—June 14—Authorizing C.N.O. Ry. to construct across Leamy Creek, Twp. of Nepean, Ct. Carleton, Ontario.

16739—June 12—Approving revised location of C.N.O. Ry. through Twps. of Barrie and [illegible] Lots of Nipissing, Ontario.

16740—June 12—Authorizing C.N.R. to cross with its Vonda Northerly and Tramway to Saskatoon, Sask.

16741—June 11—Authorizing G.T.P. Railway to construct across highway mileage 194.8 Cassiar District, B.C.

16742—June 13—Approving location of G.T.R. new station at Stratford, Ontario.

16743—June 14—Authorizing Campbellford, Lake Ontario and W. Railway (C.P.R.) to cross two highways in Twp. of East Whitby.

16744—June 13—Authorizing C.P.R. to construct additional track across highway at mileage 107.38 on Cascade, S.D.

16745—June 12—Authorizing C.P.R. to reconstruct bridges Nos. 17.0 and 17.9 on Swift Current, S.D.

16746—June 15—Relieving C.P.R. from further protecting crossing of Main Street, Walkerton, Ontario.

16747—June 15—Directing Central Vermont Railway to extend its siding at Stone, Que. Complaint Shippers of N. Stanbridge, Que.

16748—June 17—Authorizing G.T.R. to construct two sidings across William Street, Kingston, Ontario.

16749—June 8—Authorizing C.P.R. to take lands at Leaside Junction for new station site, etc., and approving new station site.

16750—June 13—16751—June 11—16752—June 13—16753—June 14—16754—June 13—Authorizing C.P.R. to construct spurs for following:—Alaska Bedding Company, Regina, Sask., J. McDiarmid Company, Calgary, Alta., American Lumber Company, Sumas, Jct., B.C., Canadian Sardine Company, Chamcook Station, N.B., Saskatoon Lumber Company, Saskatoon, Sask.

16755—June 14—Authorizing C.P.R. to construct two additional tracks across road allowance at mile 176.57 Calgary, S.D.

16756—June 14—Rescinding Order 16713 June 8, 1912, and authorizing C.P.R. to open for carriage of traffic its double track from mileage 98 at Melbourne to Carberry, mile 106.

16757—June 10—Extending until July 15, 1912, time for C.P.R. to complete fencing ordered by Order 15864 February 1st, 1912.

16758—June 15—Authorizing Campbellford, Lake Ontario and W. (C.P.R.) to cross 12 highways Twps. Bedford and Hichinbrooke, Ontario.

16759—June 8—16760—June 15—Authorizing C.P.R. to construct bridge 0.3 over Sask. River, Calgary, S.D., and reconstruct bridge No. 124.4 on Muskoka Subdivision.

16761—June 13—16762—June 17—Authorizing C.P.R. to construct additional track across highway at Westminster Jct., New Westminster, B.C., and at Kyle Street, Port Moody, B.C.

16763-64—June 14—Approving proposed changes in location of C.P.R. stations at Plaisance, Que., and Hammond, Ontario.

16765—June 15—16766—June 13—16767—June 13—16768—June 10—Authorizing G.T.R. to construct spurs for British Canadian Canners, Limited, Cobourg, Ontario, Dain Manufacturing Company, Limited, Twp. of Humberstone, Ontario, The London Concrete Machinery Company, Limited, London, Ontario, Alaska Feather and Down Company, Limited, Montreal, Quebec.

16769—June 11—Authorizing G.T.R. to reconstruct bridge at M.P. 20.56 on 22nd. Dist., Twp. of Waterloo, Ontario.

16770—June 13—16771—June 15—Authorizing G.T.P. Railway to cross highways (2) in Cassiar and Coast Districts, British Columbia.

16772—June 8—16773—June 15—Authorizing G.T.P. B.L. Company to construct station at Prongua on its Cutknife Branch, Saskatchewan, and approving location of station at Rowatt, Saskatchewan.

16774—June 13—Authorizing G.T.P. Railway to cross highway at Mileage 90.5 District of North Alberta, Alberta.

16775—June 17—Authorizing G.T.P. B.L. Co. to take possession of C.P.R. land for right-of-way, Tofield-Calgary Branch.

16776—June 10—Authorizing Algoma Eastern Ry. to construct swing bridge at Little Current, between Goat and Manitoulin Islands.

16777—June 17—Authorizing Algoma Eastern Ry. to connect with C.P.R. (Soo Branch) and Huronian Spur of Canadian Copper Co., in Twp. of Drury, Ontario.

16778—June 11—Authorizing Algoma Central & H.B. Ry. to cross highway between Cathcart St. and Wilde Ave., Tagena, Algoma, Ont.

16779—June 11—Approving plans of subway at Jasper Ave., and bridges at McKay and Victoria Avenues, Edmonton, Alta., C.P.R.

16780—June 10—Authorizing C.N.O. Ry. to cross 8 highways in Twps. of Ross and Westmeath, County of Renfrew, Ontario.

16781—June 15—Authorizing C.N.O. Ry. to cross Nicholas Creek, in Township of Marlborough, County of Carleton, Ontario.

16782—June 17—16783—June 13—Authorizing C.N.R. to cross with its Alsask, S.E., 13 highways, and with Swift Current Extension, 6 highways, in Saskatchewan.

16784—June 8—Approving by-law No. 12, British Yukon Ry., authorizing O. L. Dickeson, president, to prepare and issue tariffs.

16785—June 15—Approving clearances for V.V. & E. Ry. dock and warehouse at Burrard Inlet, British Columbia.

16786—June 14—Authorizing T.H. & B. Ry. to construct spur into premises of Geo. Frid Co., Ltd., Hamilton, Ontario.

16787—June 10—Authorizing Vancouver, Nanaimo Coal Co., to use and operate bridge where it crosses Esquimalt & Nanaimo Ry. Mountain District, Vancouver Island, B.C.

16788-89—June 15—Authorizing C.P.R. to construct spur for Gorman, Clancy & Grundley, Ltd., Edmonton, Alta., and for Oliver Lemire, Cabane Ronde, Quebec.

16790—June 10—Authorizing C.P.R. to alter location of existing tracks and to make alterations in bridges across Mountain, Aqueduct & Guy Streets, Montreal, Que.

16791—June 13—Authorizing G.T.R. to construct siding for Dominion Canners, Ltd., Simcoe, Ontario.

16792—June 15—Authorizing C.N.O. Ry. to cross McCawley's Creek, in Township of Nepean, County of Carleton, Ontario.

16793—June 17—Authorizing C.N.O. Ry. to construct bridge on land of Thomas Till, Rosebud Creek, Alberta, within 30 days.

16794—June 17—Amending Order 16661, dated March 2nd, 1912, by striking out words and figures, "Minimum charge 15 cents" at end of paragraph 3 of clause (b), to points not over 300 miles distant. Complaint, Manitoba Free Press, Winnipeg.

16795—June 11—Appointing E. Blois, Mayor, New Carlisle, Que., and David W. Mill, Q.L.S., as arbitrators, between Quebec Oriental Ry. and L. J. Riopel, in re payment for lands.

16796—June 18—Authorizing Essex Terminal Ry. Co. to open for carriage of freight traffic its line through city of Windsor, and Twp. of Sandwich West and town Sandwich, Ontario.

16797—June 18—Amending Order 16756—June 15, 1912, by adding words "and the trolley wire and wires" after first word "Tracks" in third line of second paragraph of Order.

16798—June 11—Extending until 1st October, 1912, time for completion by Toronto Eastern Railway of spur to Durham Rubber Company.

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